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ART. XXVIII.—*Explanations and Illustrations of the plan of the Smithsonian Institution;* by Prof. HENRY, LL.D., Sec. Smithsonian Institution.*

ALTHOUGH the leading propositions of the programme of the Smithsonian Institution have been fully discussed by the Board, yet it will be important to offer some remarks in explanation and illustration of them.

That the institution is not a national establishment, in the sense in which institutions dependent on the government for support are so, must be evident when it is recollected that the money was not absolutely given to the United States, but intrusted to it for a special object, namely: the establishment of an institution for the benefit of men, to bear the name of the donor, and, consequently, to reflect upon his memory the honor of all the good which may be accomplished by means of the bequest. The operations of the Smithsonian Institution ought, therefore, to be mingled as little as possible with those of the government, and its funds should be applied exclusively and faithfully to the increase and diffusion of knowledge among men.

That the bequest is intended for the benefit of men in general, and that its influence ought not to be restricted to a single district, or even nation, may be inferred not only from the words of the will, but also from the character of Smithson himself; and I beg leave to quote, from a scrap of paper in his own hand,

* The programme of the Smithsonian Institution, from the recent Report, is published on page 289. The article here presented our readers, follows that programme in the Report.

the following sentiment bearing on this point: "The man of science has no country; the world is his country—all men, his countrymen." The origin of the funds, the bequest of a foreigner, should also preclude the adoption of a plan which does not, in the words of Mr. Adams, "spread the benefits to be derived from the institution not only over the whole surface of this Union, but throughout the civilized world." "Mr. Smithson's reason for fixing the seat of his institution at Washington obviously was, that *there* is the seat of government of the United States, and *there* the Congress by whose legislation, and the Executive through whose agency, the trust committed to the honor, intelligence and good faith of the nation, is to be fulfilled." The centre of operations being permanently fixed at Washington, the character of this city for literature and science will be the more highly exalted in proportion as the influence of the institution is more widely diffused.

That the terms *increase* and *diffusion* of knowledge are logically distinct, and should be literally interpreted with reference to the will, must be evident when we reflect that they are used in a definite sense, and not as mere synonymes, by all who are engaged in the pursuits to which Smithson devoted his life. In England there are two classes of institutions, founded on the two ideas conveyed by these terms. The Royal Society, the Astronomical, the Geological, the Statistical, the Antiquarian Societies, all have for their object the increase of knowledge; while the London Institution, the Mechanics' Institution, the Surry Institution, the Society for the Diffusion of Religious Knowledge, the Society for the Diffusion of Useful Knowledge, are all intended to diffuse or disseminate knowledge among men. In our own country, also, the same distinction in the use of the terms is observed by men of science. Our colleges, academies, and common schools, are recognized as institutions partially intended for the diffusion of knowledge, while the express object of some of our scientific societies is the promotion of the discovery of new truths.

The will makes no restriction in favor of any particular kind of knowledge; though propositions have been frequently made for devoting the funds exclusively to the promotion of certain branches of science having more immediate application to the practical arts of life, and the adoption of these propositions has been urged on the ground of the conformity of such objects to the pursuits of Smithson; but an examination of his writings will show that he excluded from his own studies no branch of general knowledge, and that he was fully impressed with the important philosophical fact, that all subjects of human thought relate to one great system of truth. To restrict, therefore, the operations of the institution to a single science or art, would do

injustice to the character of the donor, as well as to the cause of general knowledge. If preference is to be given to any branches of research, it should be to the higher, and apparently more abstract; to the discovery of new principles, rather than of isolated facts. And this is true even in a practical point of view. Agriculture would have for ever remained an empirical art, had it not been for the light shed upon it by the atomic theory of chemistry; and incomparably more is to be expected as to its future advancement from the perfection of the microscope, than from improvements in the ordinary instruments of husbandry.

The plan of increasing and diffusing knowledge, presented in the first section of the programme, will be found in strict accordance with the several propositions deduced from the will of Smithson, and given in the introduction. It embraces, as a leading feature, the design of interesting the greatest number of individuals in the operations of the institution, and of spreading its influence as widely as possible. It forms an active organization, exciting all to make original researches who are gifted with the necessary power, and diffusing a kind of knowledge, now only accessible to the few, among all those who are willing to receive it. In this country, though many excel in the application of science to the practical arts of life, few devote themselves to the continued labor and patient thought necessary to the discovery and development of new truths. The principal cause of this want of attention to original research, is the want, not of proper means, but of proper encouragement. The publication of original memoirs and periodical reports, as contemplated by the programme, will act as a powerful stimulus on the latent talent of our country, by placing in bold relief the real laborers in the field of original research, while it will afford the best materials for the use of those engaged in the diffusion of knowledge.

The advantages which will accrue from the plan of publishing the volumes of the Smithsonian Contributions to Knowledge, are various. In the first place, it will serve to render the name of the founder favorably known wherever literature and science are cultivated, and to keep it in continual remembrance with each succeeding volume, as long as knowledge is valued. A single new truth, first given to the world through these volumes, will forever stamp their character as a work of reference. The contributions will thus form the most befitting monument to perpetuate the name of one whose life was devoted to the increase of knowledge, and whose ruling passion, strong in death, prompted the noble bequest intended to facilitate the labors of others in the same pursuit.

Again, the publication of a series of volumes of original memoirs will afford to the institution the most ready means of entering into friendly relations and correspondence with all the

learned societies in the world, and of enriching its library with their current transactions and proceedings. But perhaps the most important effect of the plan will be that of giving to the world many valuable memoirs, which, on account of the expense of the illustrations, could not be otherwise published. Every one who adds new and important truths to the existing stock of knowledge, must be of necessity, to a certain degree, in advance of his age. Hence the number of readers and purchasers of a work is generally in the inverse ratio of its intrinsic value; and consequently, authors of the highest rank of merit are frequently deterred from giving their productions to the world on account of the pecuniary loss to which the publication would subject them. When our lamented countryman, Bowditch, contemplating publishing his commentary on La Place, he assembled his family and informed them that the execution of this design would sacrifice one-third of his fortune, and that it was proper his heirs should be consulted on the subject which so nearly concerned them. The answer was worthy of the children of such a father: "We value," said they, "your reputation more than your money." Fortunately, in this instance, the means of making such a sacrifice existed; otherwise one of the proudest monuments of American science could not have been given to the world. In the majority of cases, however, those who are most capable of extending human knowledge are least able to incur the expense of the publication. Wilson, the American Ornithologist, states, in a letter to Michaux, that he has sacrificed everything to publish his work: "I have issued," he says, "six volumes, and am engaged on the seventh, but as yet I have not received a single cent of the proceeds." In an address on the subject of natural history, by one of our most active cultivators of this branch of knowledge, we find the following remarks, which are directly in point: "Few are acquainted with the fact that from the small number of scientific works sold, and the great expense of plates, our naturalists not only are not paid for their labors, but suffer pecuniary loss from their publications. Several works on different branches of zoology, now in the course of publication, will leave their authors losers by an aggregate of $15,000. I do not conclude in this estimate works already finished—one, for instance, the best contribution to the natural history of man extant, the publication of which will occasion its accomplished author a loss of several thousand dollars. A naturalist is extremely fortunate if he can dispose of two hundred copies of an illustrated work, and the number of copies printed rarely exceeds two hundred and fifty." It may be said that these authors have their reward in the reputation which they thus purchase; but reputation should be the result of the talents and labor expended in the production of a work, and should not in

the least depend upon the fact that the author is able to make a pecuniary sacrifice in giving the account of his discoveries to the public.

Besides the advantage to the author of having his memoir published in the Smithsonian Contributions free of expense, his labors will be given to the world with the stamp of approval of a commission of learned men; and his merits will be generally made known through the reports of the institution. Though the premiums offered may be small, yet they will have considerable effect in producing original articles. Fifty or a hundred dollars awarded to the author of an original paper, will, in many instances, suffice to supply the books, or to pay for the materials, or the manual labor required, in prosecuting the research.

There is one proposition of the programme which has given rise to much discussion, and which, therefore, requires particular explanation: I allude to that which excludes from the contributions all papers consisting merely of unverified speculations on subjects of physical science. The object of this proposition is to obviate the endless difficulties which would occur in rejecting papers of an unphilosophical character; and though it may in some cases exclude an interesting communication, yet the strict observance of it will be found of so much practical importance that it cannot be dispensed with. It has been supposed, from the adoption of this proposition, that we are disposed to undervalue abstract speculations: on the contrary, we know that all the advances in true science—namely, a knowledge of the laws of phenomena—are made by provisionally adopting well-conditioned hypotheses, the product of the imagination, and subsequently verifying them by an appeal to experiment and observation. Every new hypothesis of scientific value must not only furnish an exact explanation of known facts, but must also enable us to predict, in kind and quantity, the phenomena which will be exhibited under any given combination of circumstances. Thus, in the case of the undulatory hypothesis of light, it was inferred, as a logical consequence, that if the supposition were true that light consisted of waves of an ethereal medium, then two rays of light, like two waves of water under certain conditions, should annihilate each other, and darkness be produced. The experiment was tried, and the anticipated result was obtained. It is this exact agreement of the deduction with the actual result of experience that constitutes the verification of an hypothesis, and which alone entitles it to the name of a theory, and to a place in the Transactions of a scientific institution. It must be recollected that it is much easier to speculate than to investigate, and that very few of all the hypotheses imagined are capable of standing the test of scientific verification.

For the practical working of the plan for obtaining the character of a memoir, and the precaution taken before it is accepted for publication, I would refer to the correspondence, given in a subsequent part of this report, relative to the memoir now in process of publication by the institution. As it is not our intention to interfere with the proceedings of other institutions, but to cooperate with them, so far as our respective operations are compatible, communications may be referred to learned societies for inspection, as in the case of the above mentioned memoir, and abstracts of them given to the world through the bulletins of these societies, while the details of the memoirs and their expensive illustrations are published in the volumes of the Smithsonian Contributions. The officers of several learned societies in this country have expressed a willingness to coöperate in this way.

Since original research is the most direct way of increasing knowledge, it can scarcely be doubted that a part of the income of the bequest should be appropriated to this purpose, provided suitable persons can be found, and their labors be directed to proper objects. The number, however, of those who are capable of discovering scientific principles is comparatively small; like the poet, they are "born, not made," and, like him, must be left to choose their own subject, and wait the fitting time of inspiration. In case a person of this class has fallen on a vein of discovery, and is pursuing it with success, the better plan will be to grant him a small sum of money to carry on his investigations, provided they are considered worthy of assistance by competent judges. This will have the double effect of encouraging him in the pursuit, and of facilitating his progress. The institution, however, need not depend upon cases of this kind, even if they were more numerous than they are, for the application of its funds in the line of original research. There are large fields of observation and experiment, the cultivation of which, though it may afford no prospect of the discovery of a principle, can hardly fail to produce results of importance both in a practical and a theoretical point of view. As an illustration of this remark, I may mention the case of the investigations made a few years ago by committees of the Franklin Institute, of Philadelphia. The Secretary of the Treasury of the United States placed at the disposal of this society a sum of money, for the purpose of making experiments with reference to the cause of the explosion of steam boilers. A committee of the society was chosen for this purpose, which adopted the ingenious plan of writing to all persons in the United States engaged in the application of steam, and particularly to those who had observed the explosion of a steam boiler. In this way opinions and suggestions in great variety, as to the cause of explosions, were obtained. The most plausible of these were submitted to the test of experiment: the

results obtained were highly important, and are to be found favorably mentioned in every systematic work on the subject of steam which has appeared, in any language, within the last few years. New and important facts were established; and, what was almost of as much consequence, errors which had usurped the place of truth were dethroned.

In the programme, examples were given of a few subjects of original research to which the attention of the institution may be turned. I will mention one in this place, which in connexion with the contents of our first memoir, may deserve immediate attention. I allude to a small appropriation made annually for researches with reference to the remains of the ancient inhabitants of our country. This is a highly interesting field, and what is done in regard to it should be done quickly. Every year the progress of civilization is obliterating the ancient mounds, cities and villages are rising on the spots they have so long occupied undisturbed, and the distinctive marks of these remains are every year becoming less and less legible.

In carrying out the spirit of the plan adopted, namely, that of affecting men in general by the operations of the institution, it is evident that the principal means of diffusing knowledge must be the *press*. Though lectures should be given in the city in which Smithson has seen fit to direct the establishment of his institution, yet, as a plan of general diffusion of knowledge, the system of lectures would be entirely inadequate; every village in our extended country would have a right to demand a share of the benefit, and the income of the institution would be insufficient to supply a thousandth part of the demand. It is also evident that the knowledge diffused should, if possible, not only embrace all branches of general interest, so that each reader might find a subject suited to his taste, but also that it should differ in kind and quality from that which can be readily obtained through the cheap publications of the day. These requisites will be fully complied with in the publications of the series of reports proposed in the programme. A series of periodicals of this kind, posting up all the discoveries in science from time to time, and giving a well digested account of all the important changes in the different branches of knowledge, is a desideratum in the English language. The idea is borrowed from a partial plan of this kind in operation in Sweden and Germany; and for an example of what the work should be, I would refer to the annual report to the Swedish Academy of its perpetual Secretary, Berzelius, on physical science. The reports can be so prepared as to be highly interesting to the general reader, and at the same time of great importance to the exclusive cultivator of a particular branch of knowledge. Full references should be given, in foot-notes, to the page, number, or volume of the work from which the infor-

mation was obtained, and where a more detailed account can be found. It is scarcely necessary to remark, that the preparation of these reports should be intrusted only to persons profoundly acquainted with the subjects to which they relate—namely, to those who are devoted to particular branches, while they possess a knowledge of general principles. Sufficient explanations should be introduced to render the report intelligible to the general reader, without destroying its scientific character. Occasionally reports may be obtained from abroad—as, for example, accounts of the progress of certain branches of knowledge in foreign countries—and these may be translated if necessary, and incorporated into other reports, by some competent person in this country.

Besides the reports on the progress of knowledge, the programme proposes to publish occasionally brief treatises on particular subjects. There are always subjects of general interest, of which brief expositions would be of much value. The preparation of these, however, should be intrusted to none but persons of character and reputation, and should be subjected to a revision by competent and responsible judges before they are given to the public. They may be presented in the form of reports on the existing state of knowledge relative to a given subject, and may sometimes consist of memoirs and expositions of particular branches of literature and science, translated from foreign languages. The reports and treatises of the institution, sold at a price barely sufficient to pay the expense of printing, will find their way into every school in our country, and will be used not as first lessons for the pupil, but as sources of reliable information for the teacher.

The second section of the programme gives, so far as they have been made out, the details of the part of the plan of organization directed by the act of Congress establishing the institution. The two plans, namely, that of publication and original research, and that of collections of objects of nature and art, are not incompatible, and may be carried on harmoniously with each other. The only effect which they will have on one another is that of limiting the operation of each, on account of the funds given to the other. Still with a judicious application, and an economical expenditure of the income, and particularly by rigidly observing the plan of finance, suggested by Dr. Bache, in the construction of the building, much good may be effected in each of the two branches of the institution. To carry on the operations of the first, a working library will be required, consisting of the past volumes of the transactions and proceedings of all the learned societies in every language. These are the original sources from which the most important principles of the positive knowledge of our day have been drawn. We shall also require

a collection of the most important current literature and science for the use of the collaborators of the reports; most of these, however, will be procured in exchange for the publications of the institution, and therefore will draw but little from the library fund. For other suggestions relative to the details of the library, I would refer to the communication from Professor Jewett, Assistant Secretary, acting as Librarian.

The collections of the institution, as far as possible, should consist of such articles as are not elsewhere to be found in this country, so that the visitors at Washington may see new objects, and the spirit of the plan be kept up, of interesting the greatest possible number of individuals. A perfect collection of all objects of nature and of art, if such could be obtained and deposited in one place, would form a museum of the highest interest; but the portion of the income of the bequest which can be devoted to the increase and maintenance of the museum, will be too small to warrant any attempt towards an indiscriminate collection. It is hoped that in due time other means may be found of establishing and supporting a general collection of objects of nature and art at the seat of the general government, with funds not derived from the Smithsonian bequest. For the present, it should be the object of the institution to confine the application of the funds, first, to such collections as will tend to facilitate the study of the memoirs which may be published in the Contributions, and to establish their correctness; secondly, to the purchase of such objects as are not generally known in this country, in the way of art, and the illustration of antiquities, such as models of buildings, &c.; and, thirdly, to the formation of a collection of instruments of physical research, which will be required both in the illustration of new physical truths, and in the scientific investigations undertaken by the institution.

Much popular interest may be awakened in favor of the institution at Washington, by throwing the rooms of the building open, on stated evenings during the session of Congress, for literary and scientific assemblies, after the manner of the weekly meetings of the Royal Institution in London. At these meetings, without the formality of a regular lecture, new truths in science may be illustrated, and new objects of art exhibited. Besides these, courses of lectures may be given on particular subjects by the officers of the institution, or by distinguished individuals invited for the purpose.

Commencement of the operations of the Institution.—I was authorized, in connexion with the Committee on Organization, to commence the publication of the Smithsonian Contributions to Knowledge, and to receive any memoir which might be presented on any subject, provided it was found, on examination, to furnish an interesting addition to the sum of human knowledge,

resting on original research. The first memoir presented, and found to be of the character prescribed by the resolution of the Board, was one on the remains of the ancient inhabitants of the North American continent. It contains the result of several years' labor in the survey and exploration of the mounds and earthworks of the Mississippi valley, and will furnish a highly interesting addition to the antiquities of our country, which could not have been given to the world, but for the timely aid extended to it by this institution. The memoir was referred to the American Ethnological Society, with a request that a committee of its members might be appointed to examine and report on its character, as to fitness for publication in the Smithsonian Contributions to Knowledge. On the favorable report of this committee, and on the responsibility of the Society, the memoir has been accepted for publication. * * * *

The memoirs of Messrs. Squier and Davis will occupy the greater portion, if not the whole, of the first volume of the Contributions. The illustrations will consist of fifty-five quarto plates of the mounds, earthworks, and maps of the adjacent country; also, of about two hundred wood-cuts, principally delineations of the various articles found in the mounds. Those who consider no branch of knowledge of any value but such as relates to the immediate gratification of our physical wants, have objected to the acceptance of this memoir as one of the first publications of the institution; but it must be recollected that the will of Smithson makes no restriction in favor of any particular kind of knowledge, and that each branch is, therefore, entitled to a share of his bequest. The Ethnological memoir of Messrs. Squier and Davis was the first, of the proper character, presented for publication, and hence it was entitled to the first place in the series of Smithsonian Contributions. Besides this, it furnishes an addition to a branch of knowledge which is at this time occupying the attention of a large class of minds, and which cannot fail to be interesting to every intelligent person who would learn something of the changes to which man has been subjected.

One of the volumes of the Contributions will contain a sketch of the life of Smithson, by the Chancellor. The materials for this have been collected from the several volumes of the Transactions of the Royal Society, and the scientific journals of the beginning of the present, and the latter part of the last century. The first volume will be published as soon as the wood-cuts and plates, now in the course of preparation, are finished.

Besides the memoirs before mentioned, a number of others have been presented, some of which though apparently of interest, and the product of thought and labor, were not of the character required by the resolution of the Board, and these have

either been returned to the authors, or are in the possession of the Secretary. A number of others have also been provisionally adopted, or are in the course of preparation. Some of these are on the most abstruse parts of physical science, and all will do honor to the intellectual character of our country. Though the number of original memoirs which will be found worthy of a place in the Contributions will probably not be large, yet it will, perhaps, be best to set apart a definite portion of the income of the bequest—as, for example, at present three or four thousand dollars annually—to defray the expense of this part of the plan of increasing knowledge. A considerable portion, however, of the sum thus expended will be returned to the institution in the form of additions to its library. I may also suggest, in this place, the propriety of the adoption, by the board, of the resolution inviting all engaged in original research, to send the results of their labors for publication in the Smithsonian Contributions.

The Board also directed me to commence the collection of apparatus, and I accordingly sent orders to Europe, to the amount of twelve hundred dollars, for the purchase of such articles as could not be procured in the United States. Most of the instruments have been received, and will be found of importance, not only in the way of original research, but also in illustrating some of the most interesting and recent phenomena of physical science, as well as serving as samples for imitation to the artists of this country. It was thought that these articles would be admitted free of duty, and a petition to this effect was presented to the Secretary of the Treasury; but, though this officer is well known to be much interested in the prosperity of the institution, such is the nature of the law that the duty could not be remitted.

There is an article of apparatus which, within a few years past, has opened almost a new world of research in the phenomena of life and organization, the use of which is now indispensable in advancing our knowledge of physiology and its kindred branches of science. I allude to the achromatic microscope, to increase the power of which, the artists of Germany, France, and England have vied with each other. On account of the small number of persons who are capable of constructing the proper lenses, the best specimens of this instrument are very scarce in this country, and can be procured only at a great expense. Under these circumstances, it was a matter of much interest to learn, from a source which could be relied upon, that an individual in the interior of the state of New York had successfully devoted himself to the study of the microscope, and that he was able to produce instruments of this kind which would compete with the best of those constructed in Europe. In order to do justice to the talents and labors of this person, as well as to furnish the institution with a valuable instrument of research, I requested him

to construct a microscope, to be paid for out of the funds for the purchase of apparatus, provided that a commission, appointed by myself, should find it capable of producing certain effects. This proposition was accepted, and the result will probably be given to the Board at the next meeting.

Preparations have also been made for instituting various lines of physical research. Among the subjects mentioned in the programme as an example for the application of the funds of the institution, is terrestrial magnetism. I need scarcely say that this is a subject not only of high interest in a theoretical point of view, but also in its direct reference to navigation and the various geodetical operations of civil and military life. A resolution of Congress, authorizing the exploration of the mineral lands adjacent to the great lakes, has given to us the means of advancing this branch of knowledge with but little expenditure of the funds of the institution. The Secretary of the Treasury readily agreed to the proposition that there should be added to the mineralogical and geological surveys of these regions, determinations of the dip, the variation, and the intensity of the magnetic forces, provided that the Smithsonian Institution would furnish one set of the instruments, and take charge of the direction of the observations, and of reducing and publishing them. In the survey of the mineral lands in the vicinity of lake Michigan under Dr. Jackson, Dr. Locke, of Cincinnati, has been employed with his own apparatus; and to supply the necessary instruments for the survey in Wisconsin, preliminary steps have been taken to procure other instruments from London.

Another subject of research mentioned in the programme, and which has been urged upon the immediate attention of the institution, is that of an extensive system of meteorological observations, particularly with reference to the phenomena of American storms. Of late years, in our country, more additions have been made to meteorology than to any other branch of physical science. Several important generalizations have been arrived at, and definite theories proposed, which now enable us to direct our attention, with scientific precision, to such points of observation as cannot fail to reward us with new and interesting results. It is proposed to organize a system of observations which shall extend as far as possible over the North American continent; and in order to this, it will be necessary to engage the coöperation of the British government. I have accordingly addressed a letter on this subject to Lieutenant Colonel Sabine, Corresponding Secretary of the Royal Society, who assures me that, as soon as the plan is fully matured for this country, there will be no difficulty in establishing a system of corresponding observations in the British provinces. I have also addressed letters to several gentlemen distinguished for their attainments in meteorology, asking

for suggestions as to the plan of observation; and I beg leave to refer the Board to the report of Prof. Loomis, of New York University, and also to the communication of Prof. Espy, received in answer. The former contains an exposition of the advantages which may be derived from the study of meteorology, and what has been done in this branch of science in this country, and what encouragement there is for the further prosecution of the same subject, together with a general plan of operations. The present time appears to be peculiarly auspicious for commencing an enterprise of the proposed kind. The citizens of the United States are now scattered over every part of the southern and western portion of North America, and the extended lines of telegraph will furnish a ready means of warning the more northern and eastern observers to be on the watch for the first appearance of an advancing storm.

ART. XXIX.—*On a New empirical Formula for ascertaining the Tension of Vapor of Water at any Temperature;* by J. H. ALEXANDER, Esq.

(Concluded from page 223.)

IN the last number of this Journal, I gave the formula itself, the principles from which it was deduced, and a comparison of results by it, with those by experiment at numerous identical temperatures. Want of room excluded then what remained to complete this Memoir, in shewing the probable errors of the formula as compared with the principal experiments, and with the probable errors affecting too those different series of experiments themselves. Such a discussion is the object of the present paper.

It was already said, in the preceding part, that the most proper mode of expressing these errors is by the linear scale of temperature; which both in theory is the most important, and in practice is the most accessible and usual. In this last aspect, it is on this scale too where errors of observation are the most easy to be made, and likely to occur. With this view, the formula need be repeated here only in its converse form, (i. e., for ascertaining temperatures from given pressures,) as under:

$$t^\circ \text{ Fahr.} = 180\sqrt[8]{p} - 105^\circ{\cdot}13;$$

p being in inches of mercury: and

$$t^\circ \text{ Fahr.} = 317{\cdot}13\sqrt[8]{p'} - 105^\circ{\cdot}13;$$

p' being in atmospheres at 32°.

As this will have to be frequently applied for interpolation throughout the following discussion, it may be as well to remark

here, once for all, in justification of such application, that there need be no apprehension of its affecting the results; for it is easy to see, by inspecting a few instances taken at random from the table, that the rational deviation of the formula (i. e., the difference between calculated and observed pressures) is, for small differences of temperature, either null, or so remote a fraction as to be inappreciable in the calculation.

In applying this formula, I shall take up the principal series of experiments separately, beginning with the most recent; and shall then make assemblage of the mean results.

1. *Experiments of Mr. Regnault.*—To deduce the absolute mean error of the numerous quantities of this observer, it would be obviously requisite to take up each experiment;—a labor of which I am by no means ambitious, and which would be disproportionate at once to what is admissible in the other series presently to be noticed, and to the present aim. I shall, therefore, in all, only make use of short general methods which, without laying claim to the accuracy of geometrical refinements, will yet be recognized as having foundation in the theory of mathematical probabilities; and will, by their popular form, recommend themselves the more readily to the convictions of those who are chiefly conversant with steam in practice, and for whose benefit the whole of the present discussion is mainly intended.

It is obvious, then, in the first place, that the idea of freedom from error is associated with symmetry in the results. Such symmetry will always be observable in quantities that progress (as natural quantities may be assumed to do) according to some constant law; and as, in our ignorance of what the true law is in this case, all that we can deal with is *relative* symmetry, it is of no importance what law or formula we take as the other term of comparison, provided there be no material difference between the origin and termination of the two. I shall therefore compare a few of Mr. Regnault's observations at the lower temperatures with the results of the present formula; as under:

Temp. (Fahr.)	Pressure in inches of Mercury.		Differences.
	Observed means.	Calculated.	
−27°·112	0in·01063	0in·00664	+0·00399
−13 ·−	0 ·02047	0 ·01799	+0·00248
− 4 ·504	0 .02835	0 ·03055	−0·00220
+ 1 ·706	0 ·04567	0 ·04375	+0·00192
+ 9 ·41	0 ·06378	0 ·06643	−0·00265
17 ·402	0 ·09410	0 ·09111	+0·00299
23 ·702	0 ·12559	0 ·13451	−0·00892
27 ·626	0 ·15000	0 ·16106	−0·01106
32 ·−	0 ·18111	0 ·19561	−0·01450

It is apparent then, that so far, these observations do not follow any uniform or symmetrical progression; and without pretending to criticize the experiments themselves, which doubtless have as

much accuracy as the nature of the research admitted, it follows that, in spite of all the extraordinary tact and skill of the observer, there is yet *primâ facie* evidence against the absolute accuracy of the results. It is to be remarked upon the column of temperatures, both here and hereafter, that the remote decimals result from the reduction of Centigrade degrees to those of Fahrenheit, and are preserved because they added to the accuracy, while they did not increase the labor of the calculation. Nevertheless, the thermometer of Mr. Regnault could be read directly to the $\frac{1}{3\,0}$ of a degree Centigrade, corresponding very nearly to $\frac{1}{2\,5}$ of a degree Fahrenheit; and by estimation, to the next decimal place.

The temperatures of this table under 32° F., are lower than pressures have ever been observed at before, and rest upon single observations. They do not admit, therefore, of a comparison other than has been instituted. But the observations at 32° F., a temperature especially disengaged from instrumental errors, are, as has been already said, very numerous, and allow of being compared among themselves. Of the forty-seven observations, whose arithmetical mean pressure is given in the table, the

maximum was	0*in*·18485	corresponding to a temp. by formula of	30°·72 Fahr.
and *minimum* "	0 ·17717	" " "	29 ·77 Fahr.
and the difference	0 ·00768	corresponding diff. of temp.	0 ·95

This difference shews a mean error in temperature, unaccounted for, of 0°·425 Fahr.; and a limiting error in pressure rather more than half the difference between the formula and the mean of all the observations.

In the various series of Mr. Regnault, the temperature is given sometimes by one thermometer only, and sometimes by two, and even four. Of these latter classes, I have taken out of each series the observation where the difference of reading of the several thermometers is the greatest, to serve for another comparison, as follows:

Series.	THERMOMETER. Maximum.	Minimum.	Differences.
A.	33°·61 Cent.	33°·49 Centigr.	0°·12 Cent.
B.	42 ·63	42 ·56	0 ·07
N.	43 ·64	42 ·84	0 ·81
O.	47 ·84	47 ·14	0 ·70
P.	47 ·87	47	0 ·87
Q.	91 ·25	91 ·06	0 ·19
R.	122 ·72	122 ·50	0 ·22
S.	110 ·72	110 ·64	0 ·08
T.	137 ·75	137 ·52	0 ·23

Mean temperat. 75°·154 Cent.; mean difference 0°·366; corresponding with
" " 167°·277 Fahr. " " 0°·659 Fahr.

This difference is that of the extremes; and as the mean error of any number of observations is as likely to be *plus* as *minus*, it is equivalent in this example to an absolute error of 0°·33 Fahr.

This error manifests itself in a series where the thermometric variations are the greatest. I shall now present another where these same differences, although not perhaps the lowest of all, are yet very much less than in the last. At least, this series (which in fact forms part of the Comparative Table in the preceding Memoir) was selected without any reference to the present investigation, and with a view to the introduction of the greatest number of accordant observations; and may be considered, therefore, as offering an impartial, if not favorable, term of comparison.

The mean temperatures are given here, as in our former Table, in degrees of Fahrenheit; the individual differences between the thermometer readings are, to save calculation, retained in centigrade degrees.

Mean temperatures. Fahrenheit.	Differences of thermomet. readings. Centigrade.
151°·124	0°·52
176 ·416	0 ·30
198 ·05	0 ·13
211 ·27	0 ·06
222 ·44	0 ·08
233 ·132	0 ·16
252 ·662	0 ·22
263 ·3	0 ·14
276 ·224	0 ·20
297 ·464	0 ·19

Mean difference 0°·20 Cent.; corresponding with mean temp. 228°·2 F.; " " 0°·36 Fah., which is equivalent to an absolute mean error of 0°·18 Fahr.

We have, then, for the mean error at 32° F. . 0°·42
" " " at 167 . 0 ·33
" " " at 228 . 0 ·18

the average of which, or 0°·31

is the probable amount of error, *plus* or *minus*, with which the various series of Mr. Regnault are still to be considered as affected.

Such being the error of the experiments, I shall now show, by the following table, the comparative error of the formula. The quantities in the column of differences, are considered as on the same side of the equation with the results from the formula; those marked + indicate, therefore, the *default*, while the sign — indicates the *excess* of the calculated temperatures.

Pressures in Inches.	Temperatures. Observed.	Calculated.	Differences.
0*in* ·01063	−27°·112 F.	−20°·73 F.	+7°·38 Fah.
0 ·02047	−13	−10 ·98	+2 ·02
0 ·02835	− 4 ·504	− 5 ·74	−1 ·24
0 ·04567	+ 1 ·706	+ 2 ·49	−0 ·78
0 ·06738	+ 9 ·410	+ 8 ·65	+0 ·76
0 ·09410	+17 ·402	+16 ·27	+1 ·13
0 ·12559	+23 ·702	+22 ·25	+1 ·45
0 ·15000	+27 ·626	+26 ·08	+1 ·55 . . . +1°·53
0 ·18111	32°	30°·26	+1°·74
7 ·6977	151 ·124	147 ·80	+3 ·32
14 ·081	176 ·416	174 ·58	+1 ·84
22 ·538	198 ·050	197 ·38	+0 ·67
29 ·620	211 ·27	211 ·49	−0 ·22 . . . +1°·47
35 ·779	224°·44	221°·62	+2°·82
44 ·752	233 ·132	234 ·03	−0 ·90
63 ·333	252 ·662	254 ·24	−1 ·58
76 ·152	263 ·3	265 ·45	−2 ·15
93 ·859	276 ·224	278 ·59	−2 ·37
130 ·790	297 ·464	300 ·42	2 ·96 . . . −1°·19
	Mean difference, ...		+0°·605

This mean difference (say 0°·61 Fahr.) is the error of the formula as compared with the observations above; which are themselves the mean of more than twice as many experiments, and which may be taken as representing impartially the whole range of Mr. Regnault's results. In arriving at this mean difference, I have arranged the several instances into groups whose individual means furnish the definitive general one. This is proper, in view of the different methods of experiment which the different relations of temperature in the respective groups rendered necessary. The indiscriminate mean of all, however, (0°·657 Fahr.) is not materially variant. It will be seen that up to the point of boiling water, the formula-temperatures are generally *lower* than experiment; above that point, they are in general *higher*. I believe that such a change of sign accords with what might be anticipated, and in so far does not diminish the reliability of the formula.

The difference (+0°·61 F.) would be the absolute error of the formula, were we to assume the experiments as perfectly accurate. But they have been already shown to be themselves affected by an error of ±0°·31 F.; and the absolute error of the formula, then, may be either 0°·30 or 0°·92 F., according as the equation is made of the sum or the difference. Either of these quantities may, in the theory, represent the true error; and we have, therefore, in fine the case of an even chance for accuracy with the formula or with the observation.

Such are the conclusions that arise from the comparison with Mr. Regnault's experiments.

2. *Experiments of the Franklin Institute.*—The temperatures were read by these observers to only the nearest quarter of a de-

gree of Fahrenheit; they are, therefore, not comparable in precision, whatever they may be in accuracy, to those that have just been considered. And as but one reading either of temperature or pressure is given in each instance, they do not allow of being treated in the method that has just now been applied. I can only then compare them as in the following table:

Pressures in Atmosph'rs.	Temperatures.				Differences of Frank. Inst. in formula and experiment.
	Calculated by my formula.	Observed by F. Academy.	Observed by Frank. Inst.	Calculated by formula of Frank. Inst.	
1.	212°. F.	212°. F.	212°. F.	212°. F.	—
2.	250 ·84	250 ·52	250	248 ·8	+1°·2
3.	275 ·73	275 ·18	275	272 ·3	+2 ·7
4.	294 ·43	293 ·72	291 ·5	290 ·1	+1 ·4
5.	309 ·57	307 ·54	304 ·5	304 ·4	+0 ·1
6.	322 ·36	320 ·36	315 ·5	316 ·5	−1 ·0
7.	333 ·49	331 ·70	326	327 ·3	−1 ·3
8.	343 ·36	341 ·78	336	336 ·4	−0 ·4
9.	352 ·25	350 ·78	345	344 ·8	+0 ·2
10.	360 ·36	358 ·88	352 ·5	352 ·5	—
Mean differences,		−1°·20	−3°·45	+0°·36	

The temperatures of the Academy in this table, were not, as has been said already, from experiments at the precise epochs of pressure; but were interpolated from experimental terms not remote. Under a general principle, I excluded them from the Comparative Table in the preceding Memoir, but they satisfied even the fastidiousness of Mr. Dulong, as representing accurately the results of observation; and are therefore fit to be compared as they are here. The last line of *mean differences* shows the excess of the formula-temperatures above those of the Academy, to be not much more than *one-third* of the excess of the latter above those of the Franklin Institute; the probability of accuracy of these last then, at most, cannot be more than in the same ratio. It also shows a mean error between the formula adopted by these observers and their observations, of 0°·36; by which deviation the former, with the advantage of having the two extremes arbitrarily to coincide, yet fails to adjust itself to the latter.

3. *Experiments of the French Academy of Sciences.*—Out of the whole of this series Mr. Dulong has himself selected *eleven*, as the most unexceptionable, and has used them for a standard whereby to compare the merits of divers proposed formulæ as well as his own. It is true this group contains, among others, one of the very experiments which I have, in the preceding Memoir, noted as faulty, and as being differently recorded in the two tables; but I have not allowed myself to exclude it here any more than before. Also for his comparison, Mr. Dulong has taken the reading of only the maximum thermometer, which represented the actual temperature of the *water* in the boiler. For the present purpose, however, as in the case of Mr. Regnault's experiments, it is necessary to take the other thermometer-reading also

and register the variation of the extremes, as under. I have entered the pressures here in English inches, since they have already been reduced for the Comparative Table; but to save unnecessary calculations, I retain the temperatures in Centigrade degrees.

No. of Experiment.	Pressures in inches.	Temperatures. Maximum.	Minimum.	Diff. in deg. Centi.
1.	64*in*·14	123°·7 C.	122°·97 C.	0°·73
3.	85 ·70	133 ·3	132 ·64	0 ·66
5.	136 ·85	149 ·7	149 ·54	0 ·16
8.	194 ·42	163 ·4	163 ·00	0 ·40
9.	220 ·69	168 ·5	168 ·40	0 ·10
15.	348 ·04	188 ·5	188 ·30	0 ·20
21.	514 ·22	206 ·8	206 ·40	0 ·40
22.	516 ·84	207 ·4	207 ·09	0 ·31
25.	553 ·69	210 ·5	210 ·47	0 ·03
28.	644 ·96	218 ·4	218 ·30	0 ·10
30.	716 ·13	224 ·15	223 ·88	0 ·27

Mean difference, . 0°·3055 C. = 0°·55 Fah.,

equivalent to a mean error of ± 0°·28 Fah., arising from the uncertainties of temperature.

To contrast this with the formula we have from the same experiments as under:

No. of experim't.	Temperatures. Observed.	By the formula.	Differences.
1.	123°·7 C.	123°·9 C.	−0°·2 Centig.
3.	133 ·3	133 ·8	−0 ·5
5.	149 ·7	150 ·8	−1 ·1
8.	163 ·4	164 ·5	−1 ·1
9.	168 ·5	169 ·5	−1
15.	188 ·5	189	−0 ·5
21.	206 ·8	206 ·8	0
22.	207 ·4	207 ·2	+0 ·2
25.	210 ·5	210 ·4	+0 ·1
28.	218 ·4	217 ·7	+0 ·7
30.	224 ·15	222 ·9	+1 ·2

Mean difference, . −0°·2 C. = −0°·36 F.,

a deviation between the formula and the experiment but little more than the admitted error of the thermometric readings. The mean error of observation from this last source, was found just now to be ±0°·28 Fahr., and the mean error of the formula then may be either 0°·08 or 0°·64 of Fahrenheit. These quantities equally satisfy the equation; and the probabilities in favor of each are even.

It is observable that errors in this series come out with a different sign from those of Mr. Regnault; though the errors of observation in the two experimental series are nearly identical, as might be expected in advance from the great skill and probably equal tact of the two observers. Such a difference of sign is favorable to the character of the formula; which will be seen by combining the two results, as under:

	Error of formula.	
	Maximum.	Minimum.
From experiments of Academy of Science, .	−0°·64 F.	−0°·08 F.
" " Mr. Regnault, . . .	+0 ·92	+0 ·30
Mean error by both, ...	+0°·14	+0°·11

The nearness of these limits and the smallness of the number enclosed by them warrant, I think, a sole and entire reliance upon the formula, in the present state of experimental knowledge on the subject. I do not introduce into combination any of the other and earlier series of observations; because, from the way in which they have been reported by their respective authors, they do not admit the application of the same methods of comparison; and because it may justly be supposed that the apparatus, intellectual and mechanical, resorted to in 1829 and since, is paramount in accuracy to what had been at disposal in preceding researches.

I shall only, therefore, in farther illustration of the present formula, compare its results with those of expressions that have been proposed by other mathematicians; only extending, in point of fact, for this purpose, a similar comparison which MM. Dulong and Arago have already instituted; and using, except for the last column, quantities from the calculation of these philosophers. Their table is founded upon the same eleven observations of their own, just now quoted; and they have given for each instance the individual deviations of the several formulæ from the result of experiment. Not to employ so much room, I have thought it equally satisfactory to give the general results and inferences, as under. The deviations are given in Centigrade degrees, and belong to the same side of the equation with the temperatures given by the respective formulæ.

	Formulæ proposed by				
	Tredgold.	Roche.	Coriolis.	Dulong.	J. H. A.
Maximum deviation in excess, . .	0°·69	0°·53	0°·80	0°·40	1°·10
Maximum do. in defect, . .	2 ·11	0 ·75	0 ·25	0 ·73	1 ·20
Mean devi. without regard to signs,	0 ·79	0 ·37	0 ·44	0 ·24	0 ·60
do. with regard to do.	+0 ·338	−0 ·001	−0 ·363	−0 ·007	−0 ·20

The last formula, as is seen, although the sum of its deviations is greater than two or three of the others, lies yet more symmetrically with the curve of the experiments than any.

The three first are given by Mr. Dulong, after a copious enumeration of different formulæ, as agreeing the best with observation. Of these, in that of Tredgold and of Coriolis, the elasticity is a function of the temperature; but Mr. Coriolis uses, instead of an integral, a mixed fractional index. His exponent, instead of 7 as Dr. Young took, or 6 as Creighton and Tredgold preferred, or 5·13 as Southern chose, or 5 as Dulong adopted, is 5·335; whose coincidence with the natural law is only empirical and can

be but accidental. In the formula of Mr. Roche, (which he offers, not as a means of interpolation, but as the expression of a general physical law,) the temperature is itself an element of the index by which certain constant quantities are to be involved. The principles, however, upon which he has founded the expression, are disapproved both by Mr. Dulong and Mr. Regnault. The formula of Mr. Dulong presents a smaller aggregate deviation than any of the others; and it would be singular if it did not, seeing that it was derived from a constant furnished by his own experiments. But as might also be anticipated, this constant, taken (to four places of decimals) from the result of the highest experimental temperature, fails to apply in the lower ones. The maximum deviation under his formula, given in the last table, occurs at the lowest experimental temperature; and in fact in his final table of atmospheric pressures and corresponding temperatures, he has preferred, below the limit of four atmospheres, (145°·4 Cent. or 293°·72 Fahr.,) to abandon his own formula and use that of Tredgold. Below the ordinary atmospheric pressure, his quantities are utterly inapplicable; as will be seen by the following statement:

Pressures in Atmospheres.	Temperatures (Centigrade).			
	Observed by Regnault.	Calculated by formulæ of		
		Dulong.	Franklin Institute.	Alexander.
0·047368	32°·38	36°·16	33° 52	29°·80
0·006	0 ·00	10 ·45	4 ·28	− 1 ·08
0·000684	−25 ·00	− 7 ·25	−17 ·31	−23 ·89

The last two columns are added here for illustration; and show, among other things, that the formula of the Franklin Institute is, like that of the French Academy, inapplicable to low temperatures and pressures.

Later than these, Mr. Biot, in 1839, proposed another formula, and, in 1841, published a table calculated by it; in which the pressures are given in metres and for every degree Centigrade from − 20° to 220° Cent., corresponding to the limits of − 4° and 428° Fahrenheit. The patient labor requisite for this task, has not been overrated by its distinguished performer; as can be readily appreciated, when it is known that part of the calculations actually were, and it was apprehended that even the whole might require to be, executed with logarithms of eleven decimals, and that the constants reach even the twelfth decimal place. These constants were derived, for the higher temperatures, from the already quoted experiments of Dulong and Arago and of Taylor; and, for the lower, from unpublished experiments of Mr. Gay Lussac. The temperatures are throughout given in terms of an *air*-thermometer instead of a mercurial one; a modification which undoubtedly impresses a more systematic accuracy upon the method; but yet, in spite of the aid afforded by tabular cor-

rections for reduction, appears to diminish materially the chances of practical resort to the table itself. These temperatures, Mr. Biot, in the form first proposed by Prony, (the same which Dr. Young, with more emphasis than reflection, has called "ridiculously complicated,") employs as the exponents of a series; the peculiarity of the method, however, is in that the direct numerical result of the equation gives, instead of the pressure itself, the tabular logarithm of the pressure. It is, therefore, essentially a logarithmic formula.

I present the following comparison between it and the present formula; applied to the same instances of experiment, which have been already signalized by Mr. Dulong himself, and already quoted here. To save both the tedium and hazard of a reduction to English measures, I leave the quantities under their original denominations; and, in so far varying from the preceding instances, I give the deviation of the formulæ in terms of the pressure instead of the temperature. This method enables me, by an easy and safe interpolation, to extract the proper quantities from Mr. Biot's table; and thus to avoid the portentous labor of working out the numerical transformation of his theorem.

No. of Experiment.	Temperatures, (Centigrade.)		Pressures in Metres.		
	Mercurial thermometer.	Air thermometer.	By Biot's formula.	Observed by Dulong & Arago.	By present form.
1.	123°·7	123°·13	1·65020	1·62916	1·62022
3.	133 ·3	132 ·47	2·26396	2·1816	2·14687
5.	149 ·7	148 ·41	3·47146	3·4759	3·37449
8.	163 ·4	161 ·69	4·94220	4·9383	4·80439
9.	168 ·5	166 ·63	5·60263	5 6054	5·45121
15.	188 ·5	185 ·96	8 89046	8·840	8·73476
21.	206 ·8	203 ·60	13·05578	13·061	13·04525
22.	207 ·4	204 ·18	13·21410	13 137	13·21202
25.	210 ·5	207 ·16	14·05179	14·0634	14·10266
28.	218 ·4	214 ·75	16·36717	16·3816	16·60100
30.	224 ·15	220 ·28	18·18048	18·1894	18·64254

Not to embarrass this table with so many columns, I omit the individual deviations of the two formulæ; and present the general result as under.

	Biot.	Alexander.
Mean deviation from experiment without regard to signs,	0·02566	0·12191
Mean deviation from experiment with signs,	−0·01704	−0·02114

It is hardly necessary to repeat that the first of these formulæ is founded in part upon the very experiments with which it accords so well; and that the other was not.

The table of Mr. Biot goes up as far as 220° Cent.; but he supposes that his formula is applicable much father; and in fact he has given results, in a small supplementary table, as high as 300° C. or 572° F.; at which temperature it makes the pressure equal to almost exactly 85 atmospheres. The present formula

would make, corresponding to this pressure, a temperature of 559°·92 F. or 293°·3 Cent.; differing from the other within the correction between a mercurial and an air-thermometer.

It is at the other extremity, where we still have opportunity of referring to experiment, that the difference between the two formulæ becomes more marked; and where that of Mr. Biot, neither in its terms nor its progression, can be considered applicable. This may be seen as under:

Pressures in inches of Mercury.	Temperatures, (Centigrade).		
	Observed by Regnault.	B.	A.
0*in*·024	−23°·83	−20°·	−22°·46
0 ·033	−20°·	−17°·	−19 ·52

About the same time with Mr. Biot, other formulæ claiming (like that of Mr. Roche) a foundation on abstract theoretical principles, were proposed by Mr. Russell; who has also applied their somewhat extensive logarithmic apparatus to the calculation of a table of pressures for each degree from 32° to 250° Fahr., and then for intervals of one or more atmospheres up to fifty. This does not properly come into this discussion; because the author has found it necessary to employ different terms above and below the point of boiling water, and in point of fact to have *two* formulæ; an inconvenience, the same in kind, though not in degree, with what the object of the very research is to avoid. Nor do they counterbalance this, by a proportionate accuracy which would warrant their results to be substituted for those of experiment. On the contrary, starting from their common zero, 212°, they both deviate in their respective directions from the curve given by observation; the pressures calculated by them, are, at the two extremities, very much above any experimental ones. Not to trouble ourselves with the part of the scale below the boiling temperature, where the errors are not of so much practical importance, I give a few instances in the higher degrees, contrasted with the results of the French Academy.

Pressures in Atmospheres.	Temperatures, (Fahrenheit.)		Differences.
	French Academy.	Russell's Table.	
1·	212°·	212°·	—
5·	307 ·5*	306 ·8	0°·7
10·	358 ·9	355 ·6	3 ·3
20·	418 ·5	410	8 ·5
30·	457 ·2	444 ·6	12 ·6
50·	510 ·6	491 ·4	19 ·2

The formulæ of Mr. Regnault, to whose experimental researches such resort has been had, are in one respect in the same category as those of Mr. Russell: they are *three*, one adapted to pres-

* Mr. Russell in his comparison, as well as the Franklin Inst. in theirs, give this temperature at 308°·8; an error which has arisen from hastily reducing the actual Centigrade temp. of 153°·08, as if it were 153°·80.

sures below the melting of ice, the second reaching from that point to the ordinary atmospheric pressure, and the last, proper for high temperatures only. He promises, when his experiments in this upper part of the thermometric scale shall have been sufficiently extended and accumulated, to apply himself to the grouping of all three divisions in one comprehensive expression; and, from his well known character, much may be expected, original and appropriate. In the mean time, it would be premature to enter here upon any discussion of what is only provisional.

To resume, then, in conclusion of this rather protracted Memoir; it seems to me that in the various combinations and comparisons that have been given, the claim of the formula I propose is reasonably well established—not to be an expression of a law of nature, for to this much it makes no pretension, but to represent the phenomena of reciprocal pressures and temperatures more exactly and with a more extensive scope, than any that has yet been offered; and that, in so far, it is worthy of being taken as paramount to all that have preceded it. How far, in view of the discord yet existing between experimental results of the most recent and reliable observers, it is fit to come in as a substitute for any and all of those results themselves, is not of course for me to determine. I shall only allow myself to notice, then, its remarkable simplicity, and the consequent facility with which it adapts itself to calculation, either with or without logarithms; as well as the readiness with which, from its elements and form, it suggests itself at all times to the memory. One important use of a formula, it is to be observed, is in enabling an enquirer in any emergent case, away from books and tables, to extemporize an accurate result; in proportion to its complexity and arbitrariness, then, it becomes a question of individual strength of memory, and its resort more and more limited. In the present instance, all its terms are either given in the very case to be solved, or are physical constants at the foundation of the theory of Heat; which, I may even say, it is impossible for one, ordinarily well informed, to forget. And the composition of these terms, thus susceptible of instant recall to the mind, is so plain and necessary even, that it is equally impossible, with a moment's reflection, for one to go wrong. I believe I am only stating the simple fact when I say that, in these respects, the present formula stands alone.

Finally, then, I offer for general practical use and reference, the following table of temperatures corresponding to pressures in atmospheres and parts, through the whole range of experiment hitherto. If my labor in so far shall be fortunate enough to meet with the approval of the learned, it will be but an inconsiderable task hereafter to complete its scope, by furnishing a table of pressures at all useful temperatures for each degree of Fahrenheit's thermometer: to whose arbitrary and otherwise inconvenient scale the present investigation has served not a little to reconcile me.

Table of Temperatures corresponding to the Pressures of Steam in Atmospheres.

Pressures in Atmospheres and parts.	Temperatures in deg. of Fahrenheit.	Pressures in inches of Mercury at 32° F.	Pressures in lbs. Avdp. per sq. inch: mercury sp. gr. 13·6.
0·00025	−25°·53	0in·0075	0lb·0037
0·0005	−15 ·78	0 ·015	0 ·0074
0·001	− 4 ·84	0 ·030	0 ·0147
0·005	+26 ·01	0 ·15	0 ·0735
0·01	42 ·41	0 ·30	0 ·1470
0·05	87 ·36	1 ·50	0 ·7352
0·10	110 ·93	2 ·99	1 ·4704
0·20	137 ·39	5 ·98	2 ·9407
0·25	146 ·58	7 ·48	3 ·6759
0·50	177 ·40	14 ·96	7 ·3518
1·	212 ·00	29 ·92	14 ·7036
2·	250 ·84	59 ·84	29 ·41
3·	275 ·73	89 ·76	44 ·11
4·	294 ·43	119 ·68	58 ·81
5·	309 ·57	149 ·60	73 ·52
6·	322 ·36	179 ·52	88 ·22
7·	333 ·49	209 ·44	102 ·93
8·	343 ·36	239 ·36	117 ·63
9·	352 ·25	269 ·28	132 ·33
10·	360 ·36	299 ·20	147 ·04
11·	367 ·81	329 ·12	161 ·74
12·	374 ·72	359 ·04	176 ·44
13·	381 ·16	388 ·96	191 ·15
14·	387 ·20	418 ·88	205 ·85
15·	392 ·90	448 ·80	220 ·55
16·	398 ·28	478 ·72	235 ·26
17·	403 ·40	508 ·64	249 ·96
18·	408 ·27	538 ·56	264 ·66
19·	412 ·91	568 ·48	279 ·37
20·	417 ·36	598 ·40	294 ·07
21·	421 ·62	628 ·32	308 ·78
22·	425 ·73	658 ·24	323 ·48
23·	429 ·67	688 ·16	338 ·18
24·	433 ·48	718 ·08	352 ·89

Art. XXX.—*Considerations on the Divisibility of Magnitude;* by Alexander MacWhorter, New Haven.

Geometry is the science of magnitude; and magnitude, has been defined to be, that which has one or more of the three dimensions, length, breadth, and thickness. The conception denoted by the term magnitude, to which this science has reference, is an abstract general conception, notion, or idea, and like all other abstract notions is formed, first, by making a concrete thing or a real existence, an object of thought; next, by distinguishing in mental analysis between different characteristics of this real existence; and finally, by giving to the several characteristics thus separated and set apart in thought, names, so far as the case in hand may require. In the present instance, the concrete or real existence made the object of thought is a body, as that which occupies space. The characteristics distinguished by mental analysis and

set apart under distinct names, are the three dimensions of body, length, breadth, and thickness; while to these characteristics, taken either separately or in combination, the name of magnitude has been assigned.

Thus the conception denoted by the term magnitude has for its object, like every other abstract general conception, *some only* of the characteristics of a concrete or existing reality, which object though a mere object of thought, corresponds with what is real, but not with all that is real in the concrete reality. That which is real in every existing body and to which the object of the abstract general conception corresponds, is the *dimensions of that body*, to which of course belongs an existence distinct and separate both *from the conception itself* and from the mind which forms the conception.

Space as fitted to be occupied by body, may be considered as extension in three directions, and thus as having three dimensions, and if the term magnitude be used to denote these three characteristics of space, taken either separately or in combination, the conception denoted by the term magnitude has also, in this instance, for its object only some of the characteristics of a concrete or existing reality, and the reality to which this object corresponds, is *the dimensions of space*, to which of course belongs an existence which is *necessary*, and which at the same time is *distinct and separate* both *from the conception itself* and from the mind which forms the conception. The distinction here made between the objects of mental conception and real existences, or existences which are such independent of our thinking, though quite obvious, is of the first importance, and may be made more apparent by considering the wide difference between those objects of *thought*, which are constituted what they are *by the nature and action of the mind*, and *things*, which are what they are *in virtue of a constitution of their own;* known by our minds, to a certain extent, but still, *existing independent of our thinking*.

It is also obvious that when a general term, such as magnitude, is used to denote an abstract general conception, the object denoted by this term, in these circumstances, is subject *solely to the laws which control and determine the nature and relations of mere thoughts*, that is, *to the laws of thinking;* while if the same general term be used to denote either an object, or some property of an object, which has a *real existence independent of our thinking*, then the object denoted by this term, under these circumstances is subject to the laws which control and determine the *nature and relations of real existences*, that is, to *the laws of nature*. It is because philosophers have failed to carry out this distinction consistently, and thus have overlooked and denied their own knowledge, that so much imposing logic has been at war with common sense. Failure on this very point constitutes the grand and vital error of Hegel, with whom "thoughts are the only concrete reali-

ties, and logic, as being a true description of their processes, is at the same time a true description of the Laws of the Universe." In the confusion between thoughts and things is found the central fallacy of his Idealistic Pantheism, in which "the process of the evolution of ideas in the human mind is, at the same time, the process of all existence," in a word, in which "the dialectic process is the Method, the dialectic process the Deity, the dialectic process everything;" a system no less remarkable for the unsoundness of its premises, than for the logical rigor and scientific beauty with which it marches forward to its fatal results.

With the preceding distinction in view, the way is opened for a decision of the much vexed question respecting the divisibility of magnitude. In every age, from that of the earliest skeptic to the present moment, the contradictions on this subject, which the reasoning of geometry seems fairly to involve, have furnished weapons by which the certainty of human knowledge has been assailed; leaving room for a doubt, which the defenders of truth have appeared more willing to avoid than directly to meet; very many of them seeming to think, that the solution of the problem included something beyond the limits of the human understanding.

The difficulty referred to is this. It is well known to the geometrician that according to the principles of mathematical reasoning, every line representing magnitude is divisible beyond any assignable limit; that is, let any magnitude or line representing magnitude, be given, a magnitude can always be found, less than the given magnitude. For, let any magnitude whatever, be supposed, and, for the sake of argument, let it be considered as the least conceivable. This magnitude is some assignable distance. It can therefore become the radius of a circle. But* "if a point be taken in the diameter of a circle which is not the centre, of all the straight lines which can be drawn from it to the circumference, the greatest is that in which the centre is, and *the other part of the diameter is the least.*"

That is, a point being taken in the radius which is neither at the centre nor at the circumference of the circle, a magnitude can be cut off between this point and the circumference, (or this point and the centre,) less than radius. But, by supposition, radius was the least conceivable magnitude, a magnitude therefore has been found *less* than the least conceivable. Now this process can be repeated as often as a new radius is taken, so that, on the principles of geometry, magnitude is divisible beyond any assignable limit, in other words, magnitude is indefinitely, or as it is commonly called, infinitely divisible.

On the other hand, it is urged by the natural philosopher as well as by common sense, that there is a world which exists independent of our conceptions, governed by its own laws, which

* Euclid, Lib. iii, Prop. vii.

are not the laws of logic but the laws of nature; and that in this world are found a series of facts as certain, and which involve consequences as sure, as are the conclusions deduced by the geometrician from his definitions, postulates and axioms. The natural philosopher considers the existence of body and space, of distance and motion, to be among such facts; he knows by observation and experiment, that bodies moving in opposite directions through space sometimes pass by each other, that a body moving in the same direction with another body will sometimes overtake it, and he believes, that the opposite faces of approaching solids sometimes come in contact.

He also reasons, that if a body is in motion through space toward another body at any given distance from it, and if these two *finally come in contact*, then *antecedent to such contact* there must be a least intervening distance not occupied, or filled up, by the approaching body. In other words, that when the bodies are in contact *no distance* intervenes, and when not in contact *some distance* intervenes; distance, in the case supposed, being the interval between the opposite faces of each solid *unoccupied by the presence of either body;* while, of all the distances which can be supposed to intervene, *the least* is that *next antecedent to contact.* The same consequence follows in respect to bodies moving in opposite directions, and also in respect to bodies which overtake each other. If Achilles overtake the tortoise, the greyhound the hare, or the minute-hand the hour-hand of a clock, then there must, in the nature of things, be a least intervening distance next antecedent to each event. Should the distance thus limited be denoted by the term magnitude, then this will be the least magnitude which, in the nature of things, can be conceived to be, that is, can be conceived as having a *real* as opposed to an *ideal* existence. And if there be a least distance or length, then for the same reason, there must be a least breadth and depth, in other words, a least space; and if there be a least space, then for anything we know to the contrary respecting the nature of matter, a body may be conceived as occupying this least space, and this will be the least body, the least impenetrable solid which, in the nature of things, can be conceived to be, that is, be conceived as having a *real* as opposed to an *ideal* existence.

It follows from this, first, that every body which has a real existence, if it be a definite body such as a tree, the globe or a star, must be made up of indivisible units, or impenetrable and extended particles having a form; and next, that the magnitude of these particles can in no case be less than the least space; in other words, that the ultimate particles of a body can in no case be actually reduced so as to become less than the magnitude, which, by reasoning from the nature of actual extension, has been shown to be the least conceivable, that is, the least which can be conceived to have a *real* as opposed to an *ideal* existence.

There is an apparent objection to the existence of a least distance, or least magnitude, turning upon an ingenious fallacy respecting motion, which may as well be resolved at this point.

It appears from experiment that bodies move with unequal velocity, that is, traverse *equal spaces in unequal times;* time being measured by *some common standard.* Now, let two bodies traverse a given distance, greater than the least, with unequal velocity, that is, in unequal times; on the hypothesis of continuous motion, other things being equal, since their velocities differ, they must traverse some one least space or least distance, of which the whole distance is the sum, in *unequal times;* time being measured by some standard common to both. But to traverse the least distance is to make the least motion, or the least change of place, which, in the nature of things, can be; consequently, the bodies supposed make a least motion or a least change of place, which in the nature of things, can be, in unequal times. And if the bodies supposed make a least motion in unequal times, then bodies of unequal velocity in making some one least motion or least change of place, *while their velocity remains unequal,* require *unequal times* as *necessary to the existence* of this least motion or least change of place, in each particular case. And if bodies of unequal velocity require *unequal times* as NECESSARY TO THE EXISTENCE of some one least motion or least change of place, then this least motion *cannot be supposed to occur* in any time *less* than the one *necessary to its existence* in the particular case, *without supposing a contradiction;* that is, without supposing that a body moving with a given velocity requires a *certain time* to make some one least motion; *this time being necessary in the nature of things to the existence of the motion;* and then to suppose, that *the same body,* moving with *the same velocity,* can make the same least motion in a time *less* than the one necessary in the nature of things *to the existence* of that motion, which is absurd. Yet this is the fallacy at the basis of the various and celebrated sophisms used by the ancients against the possibility of motion. It generally comes in the shape of an interrogation, thus:

On the hypothesis of continuous motion, other things being equal, suppose two bodies moving with unequal velocity, and suppose the one moving with the greater velocity to have traversed a least distance by making the least motion or the least change of place. What has the body moving with the less velocity, and consequently requiring more time as necessay to the existence of its least motion, *done;—how far has it moved, during the time* the first body moved? Now to ask this question, is simply to ask, what has a body *done, how far* has it moved, when *one of the conditions necessary to the very existence* of its least motion, viz. the requisite time is, by supposition, NON-EXISTENT. In other words, it is to ask, if a contradiction be true, what consequences

will follow, it being the purpose of the inquirer to use the conclusions drawn from such a premise, in order to overthrow some other conclusion resting on independent evidence. So far then as this reasoning is concerned, the circumstance that existing bodies have different velocities, furnishes nothing to disprove the existence of a least distance or a least magnitude.

In fact, the proposition that every finite body is definitely divisible, in other words, is so limited by its finite nature as to be reducible only to a certain extent, is a proposition which would never have been questioned had philosophers paid more attention to the nature of the objects of thought which the premises of geometry involve; since an attentive consideration of these premises will show, that the conclusions of the geometrician respecting the infinite divisibility of magnitude do in no way conflict with the decisions of natural philosophy and common sense, but, on the contrary, are simply the enunciation of what is true in respect to the relations in which the objects of *certain abstract general notions* stand to each other, as deduced solely from what belongs of necessity *to their nature* as *mere objects of thought.*

The distance just described has been shown to be the least magnitude which, in the nature of things, can be conceived to be. Now *things* have been very beautifully classified into things existing as mere *thinks*, that is, as *mere objects of thought;* and things which are *real existences*, whether we think of them or not. Thus, in the phrase "the least magnitude which in the nature of things can be conceived to be," the term magnitude may denote either the object of an abstract conception, or a characteristic of a real existence, viz. a dimension of space; that is, it may denote either a mere object of thought or a real existence; and the phrase "nature of things" is equally ambiguous, and may denote either the *nature of mere objects of thought or the nature of real existences.* Now if the term magnitude be taken as denoting a *real* as opposed to an ideal magnitude, that is, as denoting *a dimension of space*, to which belongs an existence distinct and apart from the mind's conception of it, and the phrase "nature of things" as denoting the nature of real existences, then manifestly there is a least magnitude which in the nature of things can be conceived to be, or can be conceived to have a *real* as opposed to an *ideal* existence, viz. that distance next antecedent to the contact of bodies.

If, on the other hand, the term magnitude be taken as denoting the object of an abstract conception, that is, be taken as denoting *a mere object of thought;* and the phrase "nature of things" as denoting the nature of *thinks*, that is, *the nature of mere objects of thought*, then it is equally true that magnitude must be conceived as infinitely divisible, or more properly, as divisible beyond any assignable limit.

In this case three questions arise; first, what is the meaning of the term divisible when applied to mere objects of thought? secondly, what is the nature of the conceptions denoted by the terms mathematical line and mathematical point? and thirdly, what is it to divide a mathematical line at a mathematical point?

Respecting the first inquiry, it is evident, that while to divide means primarily to dispart, or disjoin, when material existences are spoken of, to divide when used in reference to things which are *mere objects of thought*, must mean simply *to distinguish* between them *as mere objects of thought;* so that, in this case, infinitely *divisible* means merely *infinitely distinguishable*, or distinguishable beyond any assignable limit.

In the next place a line, by definition, denotes the object of the abstract conception of length or distance, considered as a mere object of thought, apart from the abstract conceptions of breadth and depth; while a point is defined by Legendre to be, "a *limit* terminating a line."

In this definition of a point the abstract notion of length, represented by a line, is considered as ceasing or ending, and this notion of *limit to length* being a notion of the *cessation* and consequent *negation* of length, it is a conception which, in its own nature, excludes from itself the conception thus denied. It is in this view that Euclid defines a point to be "that which hath no parts or which hath no magnitude;" a definition imperfect because not convertible, everything "having no parts or no magnitude" not being a point.

But as in *things* a given distance is *in* actual space, that is, sustains the relation to actual space denoted by the terms place, situation, or position, so *in mere objects of thought* the coëxisting conceptions of abstract length, breadth, and thickness, are viewed as holding such relations to each other, as to authorize the application of the term place, or position, borrowed from real existences and applied to these conceptions in order to denote a particular relation between them. Now as mere objects of thoughts are not *in* space, the only relation which they can sustain to each other at all resembling the relations subsisting between actual existences in respect to place, is THE RELATION OF LIMITATION, the term limitation when applied to mere objects of thought denoting that the given conception is *just what it is*, AND NOT ANOTHER conception.

Thus, in answer to the second inquiry, it appears that a mathematical line is merely the object of the abstract conception of length or distance; and in respect to a mathematical point it also appears, first, that it is *not* a thing "in re" and in this sense a real existence, but on the contrary, is a mere object of thought formed by the mind, analytically, in accordance with the laws of thinking; and next, that this object of thought is *limit* as applied to the dimensions of body or of space when these are viewed as objects of abstract conception.

Now since to *divide* means *to distinguish*, when *mere objects of thought* are spoken of; in answer to the third inquiry it appears, that to divide a magnitude represented by a line, at a mathematical point, means,—*to distinguish* one magnitude *viewed as a mere object of thought* from another magnitude *viewed as a mere object of thought, by the notion of limitation*, as *the differentia*;—and then, to *represent this distinction* by the *division of an actual and visible line*. Thus, let any two magnitudes be conceived, and let them be made distinct objects of thought; each object is distinguished from the other by being conceived to be *just what it is*, as an object of thought, and, at the same time, being conceived to be NOT THE OTHER object. Now this mode of distinguishing between mere objects of thought can be repeated *just as often* as any two conceptions of magnitude can be formed, *each of which is not the other*, that is, can be repeated indefinitely; and this *distinction between* objects of *thought* can be *represented* by the division of actual lines;—this difference between these objects being simply *numerical* as mere objects of thought, having no real or substantial existence. So that in this sense, magnitudes, as mere objects of thought, are *distinguishable*, and in this sense only is magnitude *divisible* beyond any assignable limit.

The fallacy involved in the mathematical argument against the possibility of a least conceivable magnitude consists in assuming, without a shadow of warrant, that the least conceivable magnitude may be divided at a mathematical point. For the phrase, "least conceivable distance" denotes an actual distance, a *concrete* or *existing reality*. The term mathematical point, on the contrary, denotes merely the object of an abstract general conception, notion, or idea. This object is also a *mere object of thought*, having *no counterpart* or *corresponding object*, among *real existences*. Now to suppose that a *mere object of thought*, which has no corresponding object "in re," can divide a concrete or existing reality, and thus *diminish it by partition*, is to suppose, what is impossible in the known nature of things; it is to suppose, a real existence divided by a mere object of thought, the properties of a body or of space divided by an abstract idea; which is absurd. Moreover, even as a *mere object of thought*, a point, by definition, has *no extension* or no magnitude, being simply the notion of a *limit*, by which one extension is conceived of as not another. Can then extension be divided by that which has *no* extension, and magnitude be diminished by that which has no magnitude? Plainly, to divide means to *distinguish*, when mere *objects of thought* are spoken of; and it is in this sense, and in this sense only, that magnitude, which, when the subject of geometrical reasoning, is considered merely as an object of thought, is indefinitely or as it is usually, but improperly termed, infinitely divisible.

Thus by reasoning in one mode it appears that there must be a least conceivable magnitude; that is, a least magnitude which,

in the nature of things, can be conceived to have a *real* as opposed to an *ideal* existence. Here the term magnitude denotes *existing dimensions* of body or of space, and the reasoning is conducted wholly in reference to what is true respecting *real existences*. By reasoning in another mode it appears, that there cannot be a least conceivable magnitude, but that magnitude must be conceived as divisible beyond any assignable limit. Here the term magnitude denotes an abstract conception, whose object is a *mere object of thought*, and the reasoning is conducted wholly in reference to what the mind can do *in forming mere objects of thought, analytically*, and, when they are thus formed, *in distinguishing* between them.

The solution of this apparent contradiction, which has hitherto perplexed every inquiry respecting the divisibility of magnitude, turns upon the difference between things existing as mere *thinks*, that is, as *mere objects of thought*, and things which are *real existences*, whether we think of them or not. It is a distinction, which a German would immediately recognize as made between *thought in itself*—(Der Gedanke an sich), and *thing in itself*—(Das Ding an sich); and claims our assent not merely as true, but as the starting point of all truth, in respect to anything which can with propriety be called mental science. In the preceding discussion this principle has been applied to the solution of a single difficulty; what light a similar analysis may cast upon kindred problems may be left, at least for the present, to the reflections of the geometrician.

Art. XXXI.—*Researches on Salts;* by C. Gerhardt.

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The following experiments, form the outlines of a more extended research into the laws which govern the formation and the composition of salts. They are intended particularly to determine with precision the phenomena of the double decomposition of salts. I hope, through them, to arrive at a rigorous appreciation of what is to be understood by a neutral salt, an acid and a basic salt.

The part most neglected in the history of the salts, is undoubtedly that which relates to the *basic* or *subsalts*. Since the introduction of polybasic acids, it is no longer possible to give a precise definition of them; for we do not so readily perceive the difference which can exist between a salt said to be neutral, containing two or three equivalents of oxyd, and a salt called basic containing the same number. In most cases, the reactions do not indicate, in this respect, any difference.

It is generally thought that the number of subsalts formed by the same acid and the same base, is much greater than that of the corresponding persalts or acid salts. So that five or six subnitrates of lead are admitted, five or six subsulphates of copper, three or four subacetates of copper, etc., and the most irregular relations are considered as occurring in the composition of these bodies.

My experiments do not give the same results. Whenever I have been able to obtain a crystallized subsalt, or it has been possible for me so to control circumstances as to avoid a mixture, the composition of the product was exceedingly simple. I have thus been able to satisfy myself that there does not exist but a single subsalt, or at most but two, for the same acid and the same base.

There is one fact whose importance is not perceived at first sight, but which must nevertheless be borne in mind to prevent errors; it is the influence of masses in the double decomposition of salts. It is not a matter of indifference, when one solution is to be precipitated by another, whether we pour the first liquid into the second or the second into the first. It is stated, for example, in all the books, that potash if added to a solution of sulphate of copper precipitates the hydrate from it. The truth of the matter is this; if potash is added drop by drop to the salt of copper in such a way as to keep this latter in excess, we obtain a green sub-sulphate of constant composition; by operating in an inverse manner, we produce the blue hydrate perfectly pure. Without the precaution of *always maintaining in excess the liquid into which we pour the other*, we obtain nothing but mixtures. The observance of this simple rule cannot be too strongly insisted upon: very often the products of a reaction seem to have a complicated composition, when in reality they are only mixtures.

Another not less striking example of this influence of masses, is one I have noticed in the case of phosphate of soda and nitrate of lead. If we pour neutral nitrate of lead into ordinary phosphate of soda kept in excess, we shall have a flocculent precipitate of tribasic phosphate of lead anhydrous at 212° F. [$P^2O^5, 3Pb^2O$ or $PO^4(Pb^3)$]; if, on the contrary, we pour the phosphate into the nitrate in excess, we shall obtain a crystalline precipitate of a new salt to which I give the name of *nitro-phosphate of lead*. This salt crystallizes without alteration from nitric acid, in the form of small hexagonal tables, derived from a symmetrical oblique prism, and resembling the crystals of cane sugar; it does not lose weight at 212° F.

This salt constitutes a phosphate in which half the phosphorus is replaced by nitrogen, or a subnitrate in which half the nitrogen is replaced by phosphorus:

Bibasic phosphate of soda, $PO^4(Na^2H) = P^2O^5, 2Na^2O, H^2O$

Bibasic subnitrate of lead, $N^2O^4(Pb^2H) = N^2O^5, 2Pb^2O, H^2O$

Bibasic nitrophosphate of lead, $\left\{\begin{matrix}N^{\frac{1}{2}}\\P^{\frac{1}{2}}\end{matrix}\right\}O^4(Pb^2H) = \left\{\begin{matrix}N^2O^5, 2Pb^2O, H^2O\\P^2O^5\ 2Pb^2O, H^2O\end{matrix}\right.$

By calcination, the crystals give off water and nitrous vapors, and are converted, without changing their form, into quadribasic subphosphate of lead, $PO^9_5(Pb^4) = P^2O^5, 4Pb^2O$. Cold water does not change them, but boiling water converts them into tribasic phosphate of lead and neutral nitrate of lead.

Besides the influence of masses, there is another element to be considered in the double decomposition of salts, viz., temperature.

On mixing a solution of nitrate of copper with neutral sulphate of potash, we do not observe any phenomenon at ordinary temperatures. But let the mixture be heated to boiling, and a green powder will be precipitated, which when washed with boiling water, will give the composition of the quadribasic subsulphate of copper, i. e. of the same salt which is precipitated by potash in the neutral sulphate of copper, used in excess.

This fact is by no means isolated. It is even still more remarkable that sulphate of potash and sulphate of copper, being both neutral, should also be decomposed at the temperature of boiling water, into bisulphate of potash and insoluble subsulphate of copper; sulphate of potash can therefore act on sulphate of copper, as caustic potash itself would.

This reaction confirms the opinion M. Laurent and myself hold respecting the nature of acids and bases. The acids and bases are not bodies distinct from the salts. To give a good definition of salts we must say that, they are molecular systems which contain hydrogen or a metal, capable of being exchanged by double decomposition for another metal or for hydrogen. Hence potash and sulphate of potash are two salts of the same species, but belonging to different genera.

Potash, . . $O(K^2)$, potash species of the genus oxyd.
Sulphate of potash, $SO^4(K^2)$, potash species of the genus sulphate.

Moreover, although the subsulphate of copper is formed only at the temperature of boiling water, the *quadribasic subchromate of copper*, of which the composition is precisely similar, even to the proportion of water, is produced at the ordinary temperature, by mixing neutral chromate of potash with neutral sulphate or nitrate of copper. The fact which I point out then, causes an anomaly to disappear which seemed to exist between the reactions of the chromates and those of the sulphates. The analogy holds good even in the following case: if we collect the clear green precipitate, formed by boiling a mixture of sulphate of potash and sulphate of copper, or nitrate of copper, and examine it under a microscope, we shall see that it is composed of an infinite number of hexagonal tables, of a green so pale that singly they appear colorless. I find in these crystals*

* By calcination this salt gives off water and a little acid. It then takes a fine green color which stands fire. This stability might make it a suitable article to employ in painting instead of Scheele's green, of which both the preparation and the use are attended with such serious inconveniences.

$$SO^5\,(Cu^3\,K^{\frac{1}{2}}\,H^{\frac{3}{2}}) = \begin{cases} SO^3, Cu^2O, H^2O \\ SO^3, Cu^2O, (KH)O. \end{cases}$$

Derived from a subsulphate $SO^5\,(M^4) = SO^3, 2M^2O$.

It is only when we treat this salt with water, that we obtain bisulphate of potash and insoluble subsulphate of copper. Now the brown precipitate formed immediately by neutral chromate of potash in neutral salts of copper, is also a subchromate containing both potassium and copper, and boiling water extracts from it bichromate of potash, leaving an insoluble subchromate of copper.

To the action of masses and temperature, then, in double decomposition, is united also the influence of a third element, water; an influence which is permanent and not so easy to control as the others.

The water which is present, often enters into the composition of salts. Chemists have long since established a difference between water of crystallization and that of constitution so called; I shall attempt to demonstrate that basic salts obey in this respect the same laws as acid salts. I shall use dualistic formulas to show the analogy better.

Neutral oxalate of potash.	Binoxalate of potash.	Quadroxalate of potash.
C^2O^3, K^2O	$\begin{cases} C^2O^3, K^2O \\ C^2O^3, H^2O \end{cases}$	$\begin{cases} C^2O^3, K^2O \\ C^2O^3, H^2O \\ C^2O^3, H^2O \\ C^2O^3, H^2O. \end{cases}$

I find the same water of constitution in the salts called basic, only the relations of acid, base and water are interchanged. My experiments show that there are only two subnitrates of lead which may be obtained, both of them, in a crystalline state. The formation of the *bibasic subnitrate of lead* is known; I have obtained the *quadribasic subnitrate of lead*, in the form of very small rectangular tables, by a process I have elsewhere pointed out.* The other subnitrates of lead admitted by M. Berzelius are mixtures. The following is the composition of these two subnitrates at 392° F.:

Neutral nitrate of lead.	Bibasic subnitrate of lead.	Quadribasic subnitrate of lead.
$N^2O^5\,Pb^3O$	$\begin{cases} N^2O^5, Pb^2O \\ H^2O,\ Pb^2O \end{cases}$	$\begin{cases} N^2O^5, Pb^2O \\ H^2O,\ Pb^2O \\ H^2O,\ Pb^2O \\ H^2O,\ Pb^2O. \end{cases}$

Here the same relations will be noticed as between the neutral oxalate, the binoxalate and the quadroxalate of potash.

I have also corrected by new experiments the composition of the *quadribasic subnitrate of copper*, to which the experiments of Mr. Graham had led him to apply another formula. This subnitrate consists of $[N^2O^5, 4Cu^2O, 3H^2O]$; it cannot even be deprived of its water without destroying it altogether.

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* Ann. de Chimie et de Phys., t. xviii, p. 178.

I have since obtained the *subnitrate of zinc* in the form of prismatic needles, containing, as in the preceding example, $[N^2O^5, 4Zn^2O, 3H^2O]$. The formulas of Schindler and of Grouvelle are not exact. These chemists analyzed mixtures; and consequently failed to notice that the precipitate produced by ammonia in nitrate of zinc contains ammonia in combination $[N^2O^5, 4Zn^2O, H^2O, N^2H^6]$, which is not the case in nitrate of copper.* There are then three subnitrates, having a precisely similar composition, and the same water of constitution.

Subnitrate of lead Pb: $NO^6(Pb^4H^3) = N^2O^5, 4Pb^2O, 3H^2O$
" " of Cu: $NO^6(Cu^4H^3) = N^2O^5, 4Cu^2O, 3H^2O$
" " of Zn: $NO^6(Zn^4H^3) = N^2O^5, 4Zn^2O, 3H^2O$.

I think I can safely affirm that the *subnitrates of cobalt* and of *nickel* present a similar composition; however, as I have not operated upon salts of nickel entirely free from cobalt, and vice versa, I do not advance this opinion unreservedly.

Lest the analogy I have pointed out between the water of constitution of acid salts and that of basic salts, should still seem doubtful, I will add another proof. When acid salts contain a quantity of water (water of crystallization) greater than that which corresponds with the composition previously indicated, we know they are deprived of this excess by desiccation at a temperature lower than that at which the water of constitution is driven off. Thus, for example, the crystallized quadroxalate of potash contains at 212° F.,

$$\left\{\begin{matrix} C^2O^3, K^2O \\ C^2O^3, H^2O \\ C^2O^3, H^2O \\ C^2O^3, H^2O \end{matrix}\right\} + 4aq.$$

The 4 aq. are driven off at 262°·4 F. The quadribasic subsulphate of copper contains at 212° F.:

$$\left\{\begin{matrix} SO^3, Cu^2O \\ H^2O, Cu^2O \\ H^2O, Cu^2O \\ H^2O, Cu^2O \end{matrix}\right\} + 2aq.$$

The 2 aq. are also driven off between 248° F. and 266° F., while the $3H^2O$ resist a temperature of 392° F. The *quadribasic subchromate of copper* has exactly the composition of this subsulphate.

I could cite still further examples of other subsalts, my analyses of which confirm the principles I have just put forth.

Their composition is quite as simple as that of acid salts; for as there are rarely more than two acid salts for the same acid and

* Before knowing the composition of the ammoniacal subnitrate of zinc, I myself thought it identical with the other salt, for I had constantly found in the two products the same quantity of oxyd of zinc (67·1 per cent.). They do contain in fact the same centesimal proportions.

the same base, so I have been unable to obtain more than two subsalts; and if it is a case of sesqui-salts, of bi-salts, of tri-salts, of quadri-salts with water of constitution, my experiments also show that the same relations, only reversed, exist in the basic salts, so that we have subsalts, sesqui-metallic, bi-metallic, tri-metallic and quadri-metallic, with the same water of constitution as in the corresponding acid salts.

In my view, the subsalts are neutral salts of a particular type, as truly as the metaphosphates and the pyrophosphates. The phosphates which are called tribasic are nothing but subsalts, and there is the same relation between an ordinary phosphate and a metaphosphate as between a subnitrate and a nitrate. The difference is at most in their relative stability. We give the following as proofs.

On adding neutral chromate of potash to neutral nitrate of lead, we obtain a *canary-yellow* precipitate of chromate of lead; if on the contrary, we pour the same neutral chromate into the bibasic subnitrate of lead, there is formed an orange red precipitate of a chromate of lead, in which the quantity of lead is double that which it contained in the yellow precipitate.* Is not the case the same as with the phosphates and the pyrophosphates?

Mr. Graham admits that the phosphates are tribasic salts, and the pyrophosphates bibasic salts; to be consistent, must he not admit also a type of monobasic nitrates, and another of bibasic? I shall not at present discuss the theory of polybasic acids; but will confine myself to stating the following facts, which are in direct contradiction to the theory of the learned English chemist.

Ordinary phosphate of soda contains $[P^2 O^5, 2Na^2 O, 25H^2 O]$ in its crystallized state, and $[P^2 O^5, 2Na^2 O, H^2 O]$ after desiccation at 212° F. From this Mr. Graham concludes that this salt contains one equivalent of water of constitution which is replaced in the other salts by one equivalent of metallic oxyd.

But I find that the *tribasic phosphate of soda also contains at* 212° F., *one equivalent of water*, i. e. 5·2 per cent., so as to consist of: $PO^{\frac{5}{2}}(Na^3 H) = P^2 O^5, 3Na^2 O, H^2 O$.

And this water is not even entirely driven off at 392° F.; it has to be expelled by calcination, as is the case with ordinary phosphate of soda. The calcined salt regains this equivalent with the same avidity as the last mentioned salt; when slightly moistened, it becomes so strongly heated that the vessel containing it cannot be held in the hand. Besides, the fact I cite is not isolated; the *tribasic phosphate of barytes* and the *tribasic phosphate of lime* retain also the elements of water as high as 392° F. And indeed, except the phosphate of lead and that of silver, I have

* Hot solutions should be used, for the subnitrate of lead is almost insoluble in the cold.

not found a phosphate which does not retain some water at a pretty high temperature.

The pyrophosphates have afforded me similar facts. Thus the *pyrophosphate of barytes* was found to consist of:

$$PO^{\frac{5}{4}}(Ba^2 H^2) = P^2 O^5, 2Ba^2 O, 2H^2 O.$$

I am well aware that it may be objected that the temperature at which the water of constitution is expelled, is higher or lower according to the salts; this objection is based on the reactions. But have I not shown above that the composition of the precipitated salts can vary according to certain conditions of mass and temperature? It is not then exact to say that any salt, for example a tribasic, will always give, by double decomposition, precipitates of an analogous composition, i. e. tribasic. The principle based by Mr. Graham on two or three facts, is in contradiction to fifty others. Water, in which all these reactions take place, modifies them continually, and determines metamorphoses in mineral salts as well as in organic substances; at one time the elements of water combine with the salts, at another they separate from them, at another they themselves effect changes. Since the phosphates have been divided into monobasic metaphosphates, bibasic pyrophosphates and tribasic phosphates, why not establish the same differences in the nitrates, the sulphates, the chlorids? Do not the nitrates of the magnesian series exhibit different phenomena, when subjected to heat, from the nitrates of K, Na, Pb, Ba? The first always retain the elements of water, and give on heating, nitric acid, as well as a subnitrate retaining in its turn the elements of water, and the same is true of the whole magnesian series [$NO_4 (M H_2)$]; while the nitrates of K, Na, Pb, Ba, are anhydrous, and produce under the same circumstances, nitrites and oxygen gas.

I will mention another fact not less conclusive. Alum, which chemists consider as a combination of two neutral salts, has an acid reaction. At 248° F. it loses five-sixths of its water, and then becomes

$$SO^3 (K^{\frac{1}{2}} Al^{\frac{1}{2}} H^2) = \begin{cases} SO^3, K^2 O, H^2 O. \\ 3SO^3, Al^4 O^3, 3H^2 O. \end{cases}$$

This product is easily redissolved in water. But let it be dried at 392° F. and it loses all its water and becomes *insoluble.* I have produced this same insoluble alum in the wet way: all that is necessary is to sprinkle the crystals of alum with concentrated sulphuric acid, and apply heat; in a very few minutes the crystals will be changed into a crystalline powder insoluble even in boiling water, and settling in it rapidly. However, if this insoluble alum be left in the water eight or ten days, it may be seen changing by degrees into small octahedrons of soluble alum.

From this it seems to me that alum contains, as truly as the phosphates, water of constitution, which when expelled from the salts, leaves it a body altogether different.*

I would also call to mind that the anhydrous *chlorid of aluminium* is a body volatile without decomposition, while the crystallized *hydrochlorate of alumina* is decomposed by heat into *hydrochloric acid* and pure alumina.

The conclusions which follow from the facts I have instanced, may be summed up in the following manner:

The expressions neutral salt, basic salt, acid salt, are arbitrary terms, used to designate particular types of salts which differ from each other by the elements of H^2O, or of the metallic oxyd M^2O.

These types are interchangeable, with greater or less facility, according to certain conditions of mass, of temperature, etc., which it is impossible to determine with precision in the present state of the science; and there are absolutely the same chemical relations between the metaphosphates, the pyrophosphates and the ordinary phosphates, as between the nitrates and the basic nitrates, the sulphates, the bisulphates and the subsulphates, the chlorids, the hydrochlorates and the oxychlorids, etc.

It cannot be said exclusively in the ordinary acceptation of the terms, that any particular salt is monobasic, bibasic or tribasic. When the reactions take place in water, as is almost always the case, the types of the salts are modified or remain unchanged according to the degree of their stability; sometimes they remain unaltered, at others they combine with the elements of the water or of a metallic oxyd, and then give rise to a new type. But there is no rule for predicting these modifications.

To make my idea more intelligible, I will write out a few formulas.

Genus Phosphate, $PO^{\frac{7}{2}}(M^2)\pm M^2O$.

A. Sub-genus *perphosphate*,

$$PO^{\frac{7}{2}}(M^2)-\tfrac{1}{2}M^2O=PO^3(M)=[P^2O^5, M^2O].$$

All the so-called metaphosphates will belong to this type.

B. Sub-genus *equiphosphate*, $PO^{\frac{7}{2}}(M^2)=[P^2O^5, 2M^2O]$.

It includes a few pyrophosphates, and especially the salt of soda dried at 212° F., $PO^{\frac{7}{2}}(Na^2)$.

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* I will take this occasion to remark that, the *cubical alum* has exactly the same composition as the alum in octahedrons. The formation of cubical alum or Roman alum belongs to the class of phenomena of crystallization so well investigated by M. Beudant. I shall give in my work all the proofs respecting it.

M. Jacquelain (*Comptes Rendus de l'Acad.*, t. xxiv, p. 44) affirms that alum contains 22 atoms of water instead of 24 in the usual formula. This assertion is not accurate, for the new formula would require 43·38 per cent. of water, and we obtain, *by direct determination*, 45·5 per cent. Now this is exactly the same number cubical alum also gave me.

C. Sub-genus *α subphosphate*,

$PO^{\frac{7}{2}}(M^3)+\frac{1}{2}M^2O=PO^4(M^3)=[P^2O^5, 3M^2O]$.

Phosphate of soda called neutral, at 212° F., $PO^4(Na^3H)$.
" of silver, ... $PO^4(Ag^3)$.
" of lead, ... $PO^4(Pb^3)$.

D. Sub-genus *β subphosphate*,

$PO^{\frac{9}{2}}(M^2)+M^2O=PO^{\frac{7}{2}}(M^4)=[P^2O^5, 4M^2O]$.

Phosphate of soda called basic, at 212° F., $PO^{\frac{9}{2}}(Na^3H)$.
" of baryta at 212° F., . . $PO^{\frac{9}{2}}(Ba^3H)$.
Pyrophosphate of baryta at 212° F., . $PO^{\frac{9}{2}}(Ba^2H^2)$.
Basic phosphate of lead, . . . $PO^{\frac{9}{2}}(Pb^4)$.

Genus SULPHATE, $SO^4(M^2)\pm M^2O$.

A. Sub-genus *persulphate*,

$SO^4(M^2)-\frac{1}{2}M^2O=SO^{\frac{7}{2}}(M)=[2SO^3M^2O]$.

Fuming sulphuric acid, ... $SO^{\frac{7}{2}}(H)$.
Crystallized anhydrous bisulphate of potash, . $SO^{\frac{7}{2}}(K)$.

B. Sub-genus *equisulphate*, $SO^4(M^2)=[SO^3, M^2O]$.

Concentrated sulphuric acid, . . . $SO^4(H^2)$.
Neutral sulphate of potash, . . . $SO^4(K^2)$.
Bisulphate of potash at 212° F., . . $SO^4(KH)$.
Insoluble alum, ... $SO^4(K\frac{1}{2}Al\frac{3}{2})$.
White sulphate of copper, . . . $SO^4(Cu^2)$.

C. Sub-genus *β subsulphate*,

$SO^4(M^2)+M^2O=SO^5(M^4)=[SO^3, 2M^2O]$.

Crystallized sulphuric acid, density 1·780, $SO^5(H^4)$.
Alum desiccated at 262°·4 F., . . $SO^5(K\frac{1}{2}Al\frac{3}{2}H^2)$.
A salt obtained by boiling a mixture of sulphate of copper and neutral sulphate of potash, at 212° F., $SO^5(K\frac{1}{2}H\frac{3}{2}Cu^2)$.

D. Sub-genus *δ subsulphate*,

$SO^4(M^2)+2M^2O=SO^6(M^6)=[SO^3, 3M^2O]$.

Turpeth mineral, ... $SO^6(Hg^6)$.

Genus CHLORID, $Cl^2(M^2)\pm M^2O$.

There cannot be any *perchlorids*.

A. Sub-genus *equichlorid*, . . . $Cl^2(M^2)$ or $Cl(M)$.
Hydrochloric gas, ... $Cl^2(M^2)$.
Chlorid of potassium, . . . $Cl^2(K^2)$.
Double chlorid of zinc and potassium, $Cl^2(KZn)$.
Anhydrous chlorid of aluminium, . $Cl^3(Al^2)$.

B. Sub-genus *α subchlorid*,

$Cl^2(M^2)+M^2O=Cl^2O(M^4)=[Cl^2M^2, M^2O]$.

Chlorate of alumina, . . . $Cl^2O(Al^2H^2)$.
Oxychlorid of lead, ... $Cl^2O(Pb^4)$.

I give the name of *equisalts* to those which correspond to the acids produced by the combination of equal volumes of hydrogen and a non-metallic body (for example, hydrochloric gas), or by the direct combination of equal volumes of water and an anhydrid* (for example, concentrated sulphuric acid). The *subsalts* contain the elements of an equisalt, *plus* nOM^2, the persalts are composed of the same elements *minus* nOM^2.

These definitions appear to me much more precise than the names applied to the same combinations in the dualistic system.

The researches of which I have just given the first results, will soon be followed by a volume on mineral chemistry, in which I shall discuss more at length the principles of the *unitary system* (système unitaire), which along with M. Laurent, I am endeavoring to establish.

ART. XXXII.—*Observations on Rammelsberg's Analysis of the Juvenas Meteoric Stone, and on the Conclusion of Fischer's Examination of the Braunau Meteoric Iron;* by CHARLES UPHAM SHEPARD, M.D.

THE two memoirs here referred to, are contained in the Annalen der Physik und Chemie, von J. C. Poggendorff, Band lxxiii, Stuck 4, (1848).

1. *Rammelsberg's Analysis.*

This chemist commences his paper by a reference to my report on meteorites published in former numbers of this Journal,† and especially to the circumstance of my assigning the feldspathic mineral in the Juvenas stone to the species anorthite; it having been previously referred by Haüy and Laugier to feldspar, and by Rose to labradorite. This led him to undertake a fresh analysis of the meteorite, Alexander von Humboldt having supplied him with a specimen for the purpose. The investigation confirms my opinion respecting the mineral in question, while Rammelsberg affirms that it has led to new results. "Das Resultat ist nun allerdings zu Gunsten der Ansicht von Shepard ausgefallen, und liefert noch einige vielleicht nicht ganz uninteressante Details."

My report on meteorites having been mainly devoted to such productions as had been observed in the United States, it was not thought proper to allude to foreign localities, except in a very concise and general manner. This brevity led Rammelsberg to doubt whether my inference respecting the feldspathic ingre-

* I have elsewhere shown (*Journ. de Pharm. et de Chimie*, t. xi, p. 379) how we can estimate, by analogy, the volume of a non-volatile anhydrid in the state of vapor, by taking as a basis the known volume of the corresponding anhydrous chlorid.

† Vol. ii, ii ser., p. 377, and iv, p. 74.

dient of the Juvenas stone was made from the descriptions of others, or had resulted from a new examination of the mineral itself. I may therefore be allowed to state, that it was formed from an examination of a large specimen of the Juvenas stone, that had been supplied to me by H. Heuland, Esq., out of the fine meteoric cabinet of the late Sir F. Chantrey. Besides, I am ignorant of the fact, if any writer has noticed the particular crystal I have figured of the anorthite, or made the observations respecting the sphenomite of the Juvenas stone which were included in the same paper.

Rammelsberg finds the Juvenas stone to consist of the following minerals:

Anorthite, about,	36·00	p. c.
Augite, "	60·00	"
Chrome iron, "	1·50	"
Magnetic pyrites,	·25	"

With perhaps minute traces of apatite and rutile.

The anorthite is soluble in moderately strong hydrochloric acid; and consists of:

			Oxygen.
Silicic acid,	44·38		23·06
Alumina,	33·73	15·75	16·73
Oxyd of iron,	3·29	0·98	
Lime,	18·07	5·14	5·59
Magnesia,	0·36	0·14	
Soda,	1·03	0·26	
Potassa,	0·33	0·05	
Phosphoric acid,	0·54		
Proto-sulphuret of iron,	0·71		
	102·44		

The augite was insoluble in hydrochloric acid; and was decomposed by carbonate of soda (and by hydrofluoric acid for determining the soda content). It contained:

			Oxygen.
Silicic acid,	52·07	27·16	27·27
Alumina,	0·24	0·11	
Protoxyd of iron,	30·81	6·91	12·57
Lime,	5·68	1·61	
Magnesia,	9·98	3·95	
Soda,	0·41	0·10	
Chrome iron,	2·13		
Titanic acid,	0·16		
	101·48		

In supposing that the phosphoric and titanic acids were for the first time discovered in meteorites by the present research, Rammelsberg has overlooked my announcement of the existence of the

first of these in 1829, in the Virginia stone,* the reaffirmation in 1843,† of its presence in the same stone (in answer to the doubt expressed by Rumler in relation to the subject in Pogg. Band liv, Stuck 2, 1841), and repeated allusions to the same point in my recent meteoric reports: while, concerning titanic acid, it has also escaped him, that I gave in my report the following reasons for supposing that it existed in the Juvenas stone under my description of sphenomite. "Thus named from its resemblance to sphene. It occurs in brownish-grey (with a tinge of yellow) thin, tabular crystals, H. = 5·5. Implanted on crystals of black pyroxene, and associated with anorthite in the Juvenas stone. Before the blowpipe, it fuses readily to a black glass, which is magnetic. It dissolves in borax with effervescence, presenting the reaction of sphene. It is soluble in nitric acid, with the exception of a heavy white powder, insoluble in ammonia. This solution contained silicic acid and lime."

I was therefore led to regard the presence of titanic acid as nearly certain in the meteorite; and accordingly twice referred to titanium in the course of the report, as a probable ingredient of meteors.

I am not, however, certain that the phosphoric acid exists combined with lime, in the form of apatite. It is possible that magnesia enters into the compound, and that the mineral constitutes a new species. Nor can I yield to the suggestion, that the supposed titanic acid exists as rutile. On the other hand, I believe it to be present in the sphenomite, in which I also detected silicic acid, lime and protoxyd of iron.

2. *Fischer's Analysis.*

The first part of Fischer's research respecting the Braunau iron appeared in the Annalen, Band lxxii, S. 475, and was translated by Mr. Lettsom for this Journal (vol. v, ii ser., p. 338).

The principal portion of the present article relates to the composition of the insoluble ingredient of the iron, concerning which Fischer observes, that it has very properly been called *Schreibersite* by the Vienna naturalists.

Now this is the name by which, in 1846, I designated the sulphuret of chromium, found in the Bishopsville (S. C.) meteoric stone, one year before the fall of the Braunau iron occurred. And I had moreover described in my report on meteorites, the very ingredient of meteoric irons with which Fischer occupies himself in the present inquiry, under the name of dyslytite. Whether there has been an accidental interchange of my names, or whether some writer has named the insoluble substance in ques-

* See this Journal, vol. xvi, p. 199. † Ibid, vol. xlv, p. 102.

tion after Dr. Schreibers, (whom, I am happy to learn from Prof. Agassiz still survives, contrary to my impressions when I named the mineral,) I am unable to conjecture.

Fischer finds the insoluble matter to consist of:

Iron,	56·430
Nickel,	25·015
Phosphorus,	11·722
Chromium,	2·850
Carbon,	1·156
Silica,	0·985
	98·158.

He concludes that the Braunau iron consists of 95 to 98 p. c. of nickeliferous iron, with traces of cobalt, calcium, magnesium, chlorine, &c., (the sulphur and chromium, found by him and Duflos, appearing to belong to the pyrites and the insoluble, scaly mineral. He thinks that the constitution of the nickel-iron will not be found constant throughout the mass; and that no two analyses will give constant results.

The little balls of diffused pyrites are found to be a peculiar chemical compound of a simple sulphuret of iron and nickel, since it dissolves in hydrochloric acid at common temperatures with the evolution of hydrosulphuric acid, unattended by the separation of sulphur,—there remaining only a little residuum (about 1 p. c.) which contains chromium, carbon and silica.

The dyslytite constitutes the remaining ingredient of the iron; and is everywhere diffused through its mass. To its presence, Fischer, (after the suggestion of Berzelius,) attributes the Widmannstättian figures of meteoric irons.

All these ingredients are more or less crystallized. They are also magnetic; the nickel-iron and the dyslytite with polarity, the latter more so than the former; while the magnetic pyrites is simply attracted by the magnet.

New Haven, August 29, 1848.

Art. XXXIII.—*Contributions to the Mycology of North America;* by M. A. Curtis.

The history of Mycology in this country is soon told. Passing by the few species noticed by Plukenet, Clayton, Walter, and the almost always doubtful matter of Rafinesque, we find M. Bosc first giving any definite and intelligent attention to our Fungi.

In 1811, he published in the Berlin Magazine several new species found near Charleston, S. C., where, like Delile at Wil-

mington, N. C., he held the office of French Consul. His new species, which are all interesting, do not exceed half a dozen; and only one—the curious Hyperhiza—retains the place he gave them. Agaricus dorsalis, *Bosc*,—a very handsome species—belongs to Panus, *Fries*. This is very common in both Carolinas upon pine logs and stumps. Lycoperdon heterogeneum, *Bosc*, —a beautiful Fungus—belongs to Mitremyces, *Nees*. L. transversarium, *Bosc*, is Cauloglossum transversarium, *Fries*. And L. cyathiforme, *Bosc*, I suspect is a state of L. Bovista, *Linn*.

Dr. Muhlenberg established the fine genus, Glonium. Beyond this I am not aware that he added anything new.

The largest additions to the knowledge of Fungi in this country were made by the learned Schweinitz. He had already acquired a European reputation by a valuable local work on Fungi, prepared by himself and Albertini It is in this department of botany that he was especially skilled and successful, though he is generally better known among us for his investigations in other orders. In 1820, he published in the Leipsic Transactions, under the editorship of Schwægrichen, his FUNGI CAROLINÆ SUPERIORIS, being an enumeration of species already published which he had detected in North Carolina, with descriptions of new ones. The number of species in that paper is 1373.

In 1831, Mr. Schweinitz published in the Transactions of the American Philosophical Society of Philadelphia, a "Synopsis Fungorum in America Boreali media degentium." This includes all the species of the former paper, and like that, is composed of enumeration and description. It includes 3098 species, of which over twelve hundred are given as first discovered by himself. From these some deduction must be made for bad species, Mycelia, pseudo-Fungi, and a few already described by others. Still his additions, confined as his examinations were to small districts, must be considered very large and interesting. Some half dozen new genera were founded by this author.

The late Mr. Lea of Ohio, had given some attention to this class of plants. His small collection was sent to the Rev. M. J. Berkeley of England. It comprised thirty or forty undescribed species, part of which have been published by Mr. B. in Hooker's London Journal of Botany. This accomplished mycologist has also published a few other species from different parts of North America, which have been easily gathered by various collectors. Among them is a species of Cyclomyces—C. Greenei, *Berk*.—a very interesting addition to our Fungi, discovered by B. T. Greene, Esq., at Tewksbury, Mass.

At present I do not know that any American botanist is giving this obscure but interesting order any special attention, except H. W. Ravenel, Esq., of South Carolina, and myself.

In the present paper are enumerated two decades of Fungi not before included in any American publication, and one of new species. They are taken at random from lists of several hundred, which will be published from time to time hereafter. To acknowledge a heavy debt of obligation, and to insure to the following list an authority which I could not myself give it, I must here state that nearly all the species have passed under the eye of my very attentive and generous correspondent, Mr. Berkeley.

The species requiring illustration will be figured with others in a future number of the Journal.

1. AGARICUS RACHODES, Vettadini.—Ad radicem arboris mortuæ. Hillsborough, N. C.

2. MARASMIUS HÆMATOCEPHALUS, Fries.—Ad terram, fimum, ramulosque dejectos in graminosis, Hillsborough; item, Santee Canal, S. C.! ex Ravenel.

3. POLYPORUS MENANDIANUS, Mont.—In ramis emortuis. Hillsborough, N. C.

4. P. NEELGERRHENSIS, Mont.—Ad truncos prostratos præsertim Liriodendri. Hillsborough.

5. P. SULLIVANTII, Mont.—In ramis dejectis. Hillsborough.

6. HEXAGONA SERICEO-HIRSUTA, Fries.—Ad truncos cariosos. Santee Canal, S. C.! Mr. Ravenel.

7. BOLETUS SATANAS, Lenz.—Ad terram in sylvis. Hillsborough.

8. BOLETUS ANANAS, n. sp.—Pileus pulvinatus, crasse et rigide verrucoso-floccosus, luteus, ad basin floccorum venis carneis variegatus; margine tenui; hymenio plano, ad stipitem depresso, sulphureo fulvescente, vulneribus viridescentibus; tubulis mediis, obtuse angulatis; stipite lævi, solido, albo; sporidiis ferrugineis.

Species pulcherrima, subter truncos Pineos prostratos. Aug., Sept. Society Hill, S. C.; item, Santee Canal! Ravenel.

Pileus 3–4 inches broad, 1 thick. Tubes $\frac{1}{2}$ line in diameter. Stipe about 3 inches long, $\frac{1}{2}$–$\frac{3}{4}$ inches thick, the base somewhat enlarged. In habit approaches B. strobilaceus, *Scop.*, otherwise very different.

9. GEOGLOSSUM DIFFORME, Fries.—Ad terram in sylvis humidis. Society Hill.

10. TYPHULA TENUISSIMA, n. sp.—Simplex, gregaria, lævis, setaceo-filiformis, acutissime attenuata, pallida; stipite fusco-nigro; tuberculo nullo. In foliis putrescentibus Phaseoli. Aug., Sept. Society Hill. $\frac{1}{2}$–1 inch long, about $\frac{1}{8}$ line thick.

11. Stictis Sesleriæ, Lib.—In vaginis imis emortuis Andropogonis. Santee Canal. Mr. Ravenel.

12. Spermœdia Tripsaci, n. sp.—Lineari-lanceolata, lenta, squamosa, pallida, apice fuliginea. E seminibus Tripsaci. Hillsborough, N. C.

About ½ inch long, 1 line thick. In texture this is very unlike S. Clavus.

13. Sphæria Notarisii, Mont.—In ramulis emortuis Gleditschiæ et Robiniæ. Hillsborough, N. C.

14. Dothidea Pteridis, Reb.—In frondibus Pteridis aquilinæ. Rhode Island. Misit J. Olney.

15. Geaster saccatus, Fries.—Ad terram juxta truncos cariosos prostratos. Santee Canal, S. C. Ravenel.—This is a Brazilian species, and an interesting addition to our Flora.

16. Physarum decipiens, n. sp.—Adnatum, globosum et ovale (vel confluens, inde lineare et reniforme,) olivaceo-virente flavescens, rugulosum, indefinite diffractum. Floccis aureis. Sporidiis nigris. Ad truncum vivum Quercus. Aug.—Dec. Society Hill, S. C.

Less than ½ a line broad, mostly simple. Morphosis not seen. Continues five to seven days.

17. Stemonitis tenerrima, n. sp.—Sparsa, absque hypothallo; peridio ovato, acuto; capillitio sporidiisque pallide ferrugineis; stipes 2–3plo longior, subulatus, attenuatus, niger, nitens, toto penetrans. Ad caules herbarum putrescentium. Society Hill. About a line high.

18. Lachnobolus cribrosus, Fries.—Ad truncum Quercus prostratum. Hillsborough.

19. Helminthosporium macrocarpon, Grev.—In ramis variis emortuis. N. and S. Carolina.

20. Helminthosporium Ravenelii, n. sp.—Longe effusum, velutinum, fusco-olivaceum; fibris dense aggregatis, obtusis, nodosis, pellucidis; sporidiis elliptico-oblongis, 3–4 septatis.—Totam paniculam Sporoboli Indici investiens. July—Oct. N. and S. Carolina.

This is so common upon Sporobolus Indicus, that it is difficult to obtain specimens not wholly blackened by this Fungus. It is perhaps from this that it has gotten the name of "black seed grass." The seeds are far from black.

21. Helicoma Berkeleyi, n. sp.—Fibris aggregatis, atris, ramosis, opacis, septatis, flexuosis, fragilibus; sporis helicoideis, reniformibus, opacis, multiseptatis; sporidiis biseriatis non sece-

dentibus.—Ad corticem et lignum Corni floridæ et Liquidambaris, Society Hill; item, Salicis Babylonicæ, Santee Canal; Ravenel.

Appearing as black spots of two lines to several inches extent; the flocci invisible to the naked eye.

22. Triposporium elegans, Corda.—Ad caules herbarum in quisquiliis. Society Hill.

23. Aspergillus maximus, Lk.—Ad Polyporos mucidos. Society Hill.

24. Oidium pulvinatum, n. sp.—Cæspitulis pulvinatis, compactis, primo ochroleucis dein aureis; floccis fertilibus in articulos globosos ovalesque secedentibus.—Ad ligna putrida, Society Hill; item, Santee Canal; Ravenel.

Tufts roundish, 1–2 lines broad and high, sometimes confluent. An elegant species.

25. Pestalozzia pezizoides, De Notaris.—In ramis mortuis Vitis ripariæ. Hillsborough.

26. Aregma mucronatum, D. C.—In foliis Rosarum. Hillsborough.

27. Puccinia Amorphæ, n. sp.—Amphigena. Soris sparsis et approximatis in macula flavescente, subrotundis, nigris; sporidiis compactis, ovalibus, raro globosis, in medio constrictis, opacis; pedicello brevi aut nullo. Ad folia Amorphæ herbaceæ, Society Hill; item, A. fruticosæ, Santee Canal, Ravenel.—Sporidia remarkable for a loose transparent vesicular (?) epidermis often enclosing and bordering the opake nucleus.

28. Cronartium asclepiadeum, Kunze.—In foliis Comptoniæ. Hillsborough.

29. Uredo Prunastri, D. C.—In foliis Amygdali Persicæ. Society Hill.

30. Uredo Hyptidis, n. sp.—Sparsa et fasciculata, maculis emarcescentibus; pseudo-peridia parva, convexa, rotunda vel oblonga, lutescentia. Sporidia ochroleuca, ovalia obovata et subglobosa, minima, subpellucida, (sporidiolis farcta?) raro subpedicellata.—In utraque pagina foliorum, in caulibus, bracteis, floribusque, Hyptidis radiatæ.

The nearest affinity of this species seems to be with U. Labiatarum, D. C.—Santee Canal, Ravenel.

ART. XXXIV.—*Geology of South Alabama;* by C. S. HALE, Mobile.

OF the three divisions included in the tertiary system, the upper, middle and lower,—or agreeably to the nomenclature of Mr. Lyell, the pliocene, miocene, and eocene—only the last has been found with certainty to exist in Alabama; and even this appears to be limited to the older portion of the series. For certain deposits of this formation, which occur in the Carolinas and Florida, contain fossils specifically distinct from those of the Alabama beds, and which evince that the former localities embrace a newer part of the series.

The geographical limits of the formation, on the north, may be defined by an imaginary line passing between the Upper and Lower Peach-tree landings, on the Alabama river; through Moscow on the Tombecbee, thence by the Suearnochee creek, through Kemper and Carrol counties, Miss., to Arkansas state, and to Natchitoches on the Red river. On the south, the last knobs of the coralline white limestone beds disappear beneath the overlying sands and clays near the junction of the Alabama and Tombecbee rivers. And on the Mississippi the equivalents of these beds terminate near its junction with the Red river, forming a zone about sixty miles in width.

The surface of this region is generally very uneven, consisting principally of the white limestone beds, which have been furrowed out into detached precipitous masses, laying bare, in many instances, the subsequent strata, and the whole is often covered by more recent deposits of sand and clay.

The following is the order of the eocene series of Alabama.

1. (or lowest) Clay bed.
2. Lignite.
3. Sand and shells.
4. Clay bed with oysters.
5. Marly arenaceous limestone.
6. Clay bed with oysters.
7. Sand and shells.

8 and 9. White limestone.

Section of the Claiborne bluff.

The best natural section of these beds occurs at Claiborne, and may be regarded as normal deposits. This cliff which is nearly two hundred feet in height, includes the entire series of the formation with the exception of a few strata at the two extremes.

The basal bed of the cliff which may be seen here at extreme low water, is a sandy deposit, partially developed at this locality, but in other places it exhibits very decided characteristics, as an important part of the group. We have identified its existence

through a wide geographical range. Its northern outcrop may be seen near Black's and Wood's bluffs, on the two main water courses. Its thickness varies from fifteen to twenty feet. It consists of fine quartzose sand, mixed with silicate of iron, and is sometimes marly by testaceous remains, with which it greatly abounds. The best development of this deposit occurs in Clark county on Bashui creek and its branches. It is here densely charged with fossils, including nearly all the different species of testacea common in the other parts of the series, together with many new ones, some of which are unique. Of the latter may be noticed a species of Rostellaria, differing from Lea's R. Lamarckii in having a more attenuated rostrum, and a very prominent tubercle situated on the back of the body whorl. Also a new species of Voluta, having a general resemblance to V. luctator of the London clay, but differing in a remarkable deposit of enamel behind the aperture, forming a large bourelet covering half the spire to the summit, enveloping also the folds of the columella, and otherwise flattening and deforming the symmetry of the aperture. Also a new species of Tornatella: shell robust, spirally fluted with flattened ribs, spire attenuated, two stout folds on the columella, outer lip denticulated. A new species of Ranella transversely ribbed, cancellated, with small intermediate varices between the two principal ones, and coarse indentations on the inner margin of the outer lip. Another species answering to Cassidaria carinata, *Lam.*, figured in Lyell's Principles of Geology, as a characteristic of the European equivalents; the only difference exhibited in our shell is that of possessing three instead of four rows of tubercles. The bed under consideration which we designate No. 3, is the source of several mineral springs, as the Tallahatta, Bladon, Monroeville, Lauderdale, and some others of less notoriety. These all appear to be identical in their mineral properties, which are evidently derived by infiltration from the ingredients of the subjacent bed of lignite through which they percolate. But this bed of lignite, (No. 2,) for other reasons may be considered a very important part of the series. It lies upon the lowest bed of the group, which last, No. 1, consists of bituminous clay, more or less sandy and sometimes containing large masses of sandy concretions. This clay bed is about twenty-five feet in thickness and rests conformably upon the subjacent cretaceous beds. It may be traced along the Alabama river from Tate's ferry to near the Upper Peach-tree landing, where it terminates; also on the Tombecbee river from Wood's bluff to its termination, at Black bluff. It appears to be destitute of fossils; but with its associated bed of lignite, it forms a very distinct line of demarkation between the tertiary and cretaceous systems. At Grayson's landing on Coal bluff, as it is sometimes called, the deposit of lignite is well developed in con-

nexion with the overlying sand and subjacent clay bed. Its thickess here amounts to four feet. The color is dull black, texture compact with occasional thin fibrous laminations, structure massive, sometimes fragmentary; it burns without swelling or caking, and abounds with sulphate of iron both crystallized and amorphous.

Want of leisure has prevented a suitable examination of its organic remains. The vegetable part however furnishes decided evidence of its intertropical character. Between our two principal water courses this deposit of lignite lines the bottom and sides of the streams through a zone ten or fifteen miles in width. It occurs in a western direction in Pigeon creek on the border of the state of Mississippi, near the northern limits of Washington county. It is found also at Natchitoches on Red river, where the underlying bed consists of a grayish plastic clay, very adhesive; on Bedia's creek near the Trinity river, Texas; at Robin's ferry on the Brazos; and at Bastrop on the Colorado. At all these places the lignite occupies the same relative position in the series, and is probably continuous through the whole of this extent, marking the former coast line.

The greensand deposit, No. 3, already noticed as partially developed at the base of Claiborne bluff, passes insensibly into No. 4, an argillaceous muddy deposit above, with a thickness varying from fifteen to twenty feet. The fossils of this bed are limited almost exclusively to the Ostrea genus; the only exceptions appear to be the Cardita planicosta, two or three species of Turritella and an Arca. The stratum No. 4, also makes its appearance at Coffeeville landing on the Tombecbee, where it exhibits the same identical fossiliferous character.

There occur here however a new species of Turbinolia, resembling very much the Turbinolopsis ochracea of Lamouroux—two or three new species of Lonsdale's new genus Endopachys, also a new species of Lunulite. This stratum may also be seen at Bell's landing on the Alabama, where its thickness amounts to fifty feet. At the bottom of this cliff with the Ostrea common in the stratum, I found the Cardita planicosta of very large dimensions.

The next in the ascending series is a limestone deposit with sandy and argillaceous ingredients variously intermixed. The few species it contains are common also in the other beds, and probably were introduced here in some adventitious way. I have not been able to discover this deposit anywhere else except in the Claiborne section.

To this limestone deposit, another clay bed, No. 6, succeeds, being about twenty feet in thickness. It is remarkable for nothing else but a band of oysters of the selliform species, all of which are of a mature size, and probably lived on the spot. This

clay bed with oysters, occurs again five miles below on the river, in the same relative situation in the series; in both of which instances the oysters are full grown; whereas in the lower bed both at Claiborne and Coffeeville, they are principally of immature size, a peculiarity which may possibly be owing to the circumstance of their exposure in the latter case to the influence of a current, when small and easily drifted.

The next bed, No. 7, is a deposit of fine yellow quartzose sand with a small mixture of silicate of iron; in some instances it is highly ferruginous. It contains nearly all the different species of fossils found in the series. Its medium height is about fifteen feet. I obtained, at different times, from this stratum, various species of radiata, mollusca, reptiles, fish, and mammifers, amounting in all to about three hundred. Those which embrace the greatest number of individuals, belong to the genera, Cytherea, Cardita, Crassatella, Pectunculus, Crepidula, Oliva, Turritella, Dentalium, and Corbula. Several of these species are grouped in distinct layers or bands; but the greater portion of them seem to have been promiscuously thrown together, as if they had been exposed to the violent agitation of the waves. The testacea of this bed are all marine and nearly all of them of the littoral kind. Not a single species of land or freshwater shells has yet been found in any of these beds.

A small seam of earthy lignite, disseminated in small fragmentary masses, forms a somewhat striking feature about midway in the yellow sand; and associated with it were found the only remains yet discovered of terrestrial mammalia. The greater portion of the fossils peculiar to this bed have already been described. We shall therefore omit the notice of such, and at present merely allude to those in our cabinet which are unique. One of the most remarkable of these is that of a Nautilus, which appears to be restricted to this deposit. Our specimen is too imperfect to admit of a very particular description. In its entire state it could not have been less than one foot in diameter. We have also obtained from this deposit several new species of Echinoderms, and Madrepores, and many new species of Molluscs, of the genera Fusus, Terebra, Ancillaria, Phasianella, Murex, Turretilla, Solarium, Scalaria, Pyrula, Venus, Arca, Tellina.

Of fish, there are remains of the Pristis, spines of the Ray, various species of palatal teeth, vertebræ of many unknown species, and teeth and vertebræ of the shark. Of terrestrial mammalia there are several maxillary fragments of small quadrupeds. The most interesting relic of this class is the cranium of a quadruped, whose type is now exclusively confined to the southern part of this continent. It belongs to an extinct genus of the Edentate order of animals, and is allied to the existing armadillos. Our fossil answers to a skeleton lately found in the tertiary beds near Buenos Ayres,

called the glyptodon. The occipital surface of the skull slopes forward, from the plane of the occipital foramen, at an angle of 45°. In the small existing armadillos it is vertical. In the glyptodon this surface is divided by a medium vertical ridge, and separated from the upper surface of the skull by a transverse ridge. The interorbital part of the upper surface of the cranium is somewhat broad, and nearly flat, and concave at its posterior half. The anterior part of the base of the cranium, shows the large cavities of the olfactory bulbs, and the remains of an extensive cribriform process, evincing that the organ of smell was well developed. The existing species of this order of animals inhabit the warm and temperate parts of South America. It is characterized by the sloth, the ant-eater, and the armadillo. In their habits they are nocturnal and gregarious, burrow in the ground, and feed on dead bodies, reptiles, the root of the manioc, and other succulent plants. Were this the only relic of the family that has been found in this part of the continent, it might seem presumptuous to deduce any special conclusion from its occurrence in our tertiary beds. A single individual might, for once, have wandered beyond the limits of its habitat, or by some accidental means have been transported into a foreign situation. But since other kindred remains of this family, the megatherium, for instance, have been found in this part of the continent, we may reasonably conclude that it was once their proper abode, and zoologically connected with the southern division. What might have been its condition then, and what are the changes that have since occurred to have caused the present diversity of the two faunas, are inquiries that force themselves upon our consideration. That this diversity has been produced by external physical causes, such as change of climate, and modifications of the earth's surface, can scarcely be doubted; for no other reason can be assigned why a living typical representation of these extinct species, should not still be found north as well as south of the Mexican gulf.

That the geographical distribution of faunas has changed since the opossum lived in the British isles, and the mastodon was indigenous to both North and South America, are interesting facts to be accounted for in the adaptation of the nature and habits of animals to the external circumstances in which they are placed. Such an adaptation furnishes the reason of the limitation of the present congeners of our species to their South American locality. And we have only to suppose an assimilation of conditions between the two parts of the continent, and perhaps the substitution of an unbroken connection by means of the continuation of the table lands of Mexico, or the Carribean Islands, in order to produce a similar correspondence between our present and extinct faunas.

But to pursue the details of our researches, we remark, that the bed, No. 7, which forms so interesting a feature in the Claiborne section, is exhibited in many other places, and often becomes an important criterion to determine other parts of the series. Two miles below, near Forward's landing, it makes its appearance in a similarly elevated cliff, and becomes quite as interesting for the abundance of its fossils, with no apparent diversity of species. And again, still farther down the river, at Barefield's plantation, it is developed about ten feet above the water, in connection with the subjacent oyster bed.

Four miles farther south, at the bend of the river, near limestone creek, the bed, No. 7, appears at low water in connection with the overlying Claiborne beds. It also occurs in the interior of Clark county, where it is exposed in a ravine at the base of the white limestone hill; on Limestone creek, near the salt works, and at the base of St. Stephen's bluff one mile above the landing: thence in a northeasterly direction, its outcroppings may be traced to the borders of Mississippi.

In all these situations, the stratum under consideration exhibits a remarkable identity both in its mineral and zoological characters; it also retains its parallelism with the exception of the two first localities, where its uncommon elevation may be attributed to the unevenness of the older cretaceous beds which it overlaps in a tortuous and irregular manner.

The remaining part of the eocene series, exclusive of the superficial sand and clay, may be included under the appellation of white limestone. The peculiarities of this part of the series, seem to require such a distinction. It consists of limestone, both compact and loose, somewhat arenaceous and marly below, but passing upwards into a very pure carbonate of lime, having often a white chalky appearance without signs of stratification. But the distinction regards more especially its fossils. Though the general type of its fauna identifies it as a part of the eocene group, yet there is a manifest peculiarity; the upper portion especially consists almost entirely of comminuted remains of marine organisms, such as Orbitolites and other coralline forms. Indeed the aspect of the species in the subordinate part of the formation presents obvious differences, such as occurrences of Echinoderms of various genera, pectens and oysters of a peculiar type, and above, a very unique species of cetacean mammal. These peculiarities were, until lately, considered a sufficient reason to class these deposits as a newer part of the cretaceous system. But it is now ascertained both by stratigraphical and paleontological evidence, that they form an upper section of the eocene strata. We have fixed the commencement of this subdivision immediately after the bed last considered, No. 7, for here we find an evident transition from the prevailing forms of the preceding beds

to a peculiar zoological type that marks a very evident change of geological condition.

With a few of the smaller less characteristic species that have passed into these upper beds, we meet with a large proportion of Radiata, such as Scutella, Spatangus, &c., and as we ascend in the series, various new species of pecten and oysters, to the almost entire exclusion of the species that prevailed in the preceding deposits.

The ferruginous sand which we regard as the transition bed, is not very distinguishable from the bed immediately preceding, except for the large number of Scutellæ which it contains. Six miles below Claiborne at the bend of the Alabama, it may be seen with a large amount of its characteristic fossils, where the superjacent strata are identical with those similarly associated in the Claiborne section. But the series are continued upwards so as evidently to connect with the Orbitolite limestone, and a few miles down the river near Dale's ferry, a similar connexion may be seen with a very full development of the Orbitolite limestone. Many other instances of this kind might be adduced if it were necessary to show that such is the true order of the series.

The white limestone formation is exhibited in detached and uneven masses, constituting a prominent feature of the counties of Munroe, Clark and Washington. In the neighboring counties, and even through the state of Mississippi, the white limestone is replaced by a blueish argillaceous marl, in some instances loose, in others hard and compact. After the white limestone was deposited, new agencies appear to have been brought into operation, which furrowed out its beds, and, in many instances, laid bare even the lowest of the subjacent strata. These effects are more manifest in the northern limits of Clark county, where the denudations have extended to the lowest eocene beds and formed ravines between the limestone hills in some instances to the depth of three or four hundred feet. These are the only marked effects of violent disturbance that occur in any part of the series, and they very probably belong to a much later date, perhaps to that change of geological conditions indicated by the overlying mass of sand and clay. But whether this superficial mass was formed within or after the eocene period, we have not the means of knowing, as it is destitute of fossils. The gravel and rolled shingle however seem to indicate a kind of agency more in accordance with events of some subsequent date, than with that of the tranquil deposition of the preceding eocene strata.

The train of these remarks has caused us to omit noticing the paleontological features of the white limestone formation. The orbitolite and other coralline remains which constitute its principal ingredients have already been alluded to. Their accumulation here furnishes a striking illustration of the remark, "That

the most important results are often produced by the simplest means." For what can seem more insignificant than one of these small discoidal organisms more attenuated than the thinnest paper? or the still smaller coralline forms scarcely distinguishable from a microscopic fibre? But insignificant as they appear in a separate point of view, they constitute the entire mass of many of these limestone hills.

In addition to this mass of zoophytes, may also be noticed various species of Echinoderms, some of which are quite unique; they belong to the genera, Spatangus, Scutella, and Echinus. One species of Spatangus is very similar to S. retusa, a cretaceous fossil.

It may be presumed, from this similarity of fauna, that the conditions in which the two formations were produced, could not have been very different. If the Mississippi equivalent of the white limestone, which is a bluish marly limestone, were taken for the type, it must be admitted that a striking similarity also exists even in their mineral character.

The molluscs peculiar to these beds are Spondylus dumosum, Pecten Poulsoni, P. perplanata, Ostrea panda, O. cretacea, and indeterminate casts of Cyprea, Conus, Natica, Mya, and Modiola. The remains of fish are principally of the Placoid order, as the ray, shark, and pristis. But the most wonderful of all these associated tribes, is the noted cetacean called the Zeuglodon.

The metropolis of this strange inhabitant appears to have been the tertiary of Alabama. For here principally the relics abound. They are scattered more sparingly in a westerly direction as far as the state of Arkansas, and eastwardly to South Carolina. Their geological situation is in the tertiary beds immediately below the orbitolite limestone, near the denuded surface of those gentle declivities which form a step to the summit of these hills. They are seldom found in their natural position—but in many instances appear to have been torn, by some disturbing cause, from their ancient resting place and scattered to remote distances. We are informed by some of the early settlers that entire skeletons were formerly exposed upon the surface of the earth, and that these remains were in some instances so abundant as to become an encumbrance upon the plantations. We obtained a vertebra of this animal from the white limestone strata of the Claiborne section; and the fragment of another from a similar section near Forward's landing. We also obtained a large portion of the vertebral column in the western part of Clark county; and the lower maxillæ, teeth and other fragments of the head, near Bucatunnie creek, Mississippi.*

* We omit here some descriptive remarks on the Zeuglodon, as the skeleton has been elsewhere described with more fullness.—Eds.

These eocene strata were all evidently formed in circumstances exempt from the influence of disturbing causes. With the exception of a few local interruptions of level, attributable to the inequalities of the older beds, they appear to retain their parallelism in all their geographical extent. It is very rare that in remote situations, a diversity in the sea-bottom, or some other geological change, does not produce a marked diversity in the character of the deposits; but this series furnishes a remarkable exception in this respect. A striking uniformity in the lithological and zoological characters of the same beds, prevails wherever they have been observed. This uniformity evinces not only the absence of disturbing causes, but a very unusual coincidence of geological conditions. The denudation of the white limestone beds, being considered as a subsequent event, is of course not included in this category.

Another circumstance, worthy of consideration, is the absence of land and fluviatile testacea, and the exclusive limitation of the fossils of these beds to a marine fauna, with the exception of the few remains of terrestrial animals already noticed. Even the estuary group of Cerithia so numerous in the European equivalents, is very sparingly represented in these deposits.

Restricted as these beds are to a marine fauna, it is rather surprising that they contain a very considerable abundance of vegetable remains. Nothing very precise however has been ascertained respecting the situation of the land from whence these remains were derived. It is evident however that this part of the globe, in the period under consideration, was very different from what it is at present.

From the general character of the organic remains, as well as from various other considerations, it is not likely that these deposits were formed in very deep water. We may rather conclude, from the indications exhibited, that they were at one time sedimentary shoals, or a mud-bank, forming a suitable habitation for the Acephala and other organisms that cannot live in the open ocean; and at another time that this body of water was so changed as to become expanded into a widely extended ocean, with a corresponding change of fauna, suited to its varying zones of depth, either such as were adapted to inhabit a shallow deepening sea, or the still greater depths of a more expanded ocean.

Taking into view the regular and quiet operation of the agencies which mark the progress of events in the series, it is rather surprising, at first, to notice the contrast exhibited between this and the preceding cretaceous group; the peculiarity of its organic remains, gives to the tertiary fauna more the appearance of a new creation than a gradual development of the same general system. But as the upper portion of the cretaceous equivalents

is probably wanting in our series, and possibly some other intervening deposits not yet made out, a sufficient time may have elapsed between the deposition of the two groups, to furnish a partial explanation of the remarkable change of conditions they manifest. * * * *

ART. XXXV.—*On the Oxydation of Uric Acid by means of Potassa and Ferridcyanid of Potassium;* by ADOLPH SCHLIEPER.

ALTHOUGH a great many products of the decomposition of uric acid have been discovered during the last ten years, yet they were nearly all obtained only by the oxydating influence of acids or acid bodies. The oxydating action of brown oxyd of lead and nitric acid on uric acid has been investigated by Liebig and Wöhler in a masterly manner.* I have already demonstrated the formation of alloxan and urea from uric acid, by the action of chlorate of potassa and hydrochloric acid. With these exceptions, the influence of no other oxydating body on uric acid, has ever been the subject of an original investigation. For these reasons it seemed to me interesting, to study the oxydation of uric acid in an alkaline solution, because its decomposition, effected altogether by a new mode, might throw light on many points, still enigmatical, in the constitution of the products of the decomposition of uric acid.

A notice from Mercer, in regard to the bleaching of cotton cloth dyed indigo-blue, by means of a solution of caustic potash and ferridcyanid of potassium, suggested to me the idea of applying the same mode of oxydation to uric acid; but in doing so, I found it exceedingly difficult, to separate the resulting salts of potash in such a way, that the newly generated and so easily decomposable products of uric acid should remain unchanged.

It is well known that one equivalent of ferridcyanid of potassium with one equivalent of potash are decomposed in presence of oxydizible substances, in such a manner, that the red prussiate of potash takes up one equivalent of potassium, forming with it two equivalents of ferridcyanid of potassium, during which the oxygen of the potassa set free combines with the oxydizible body.

Ferridcyanid of potassium $3KCy+Fe_2Cy_3 = 3KCy+Fe_2Cy_3$ $+Cy$ with potassa $(K+O)$ = two equivalents of prussiate of potossa $= 4KCy+Fe_2Cy_3$, and one equivalent of oxygen.

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* Annalen der Chemie und Pharmacie, Band 26, p. 241.

I communicate the following results, as they presented themselves in the course of the investigation.

To observe the action of ferridcyanid of potassium and potassa on uric acid, some previous essays were made, in which very small quantities of powdered red prussiate of potassa were put into a nearly cold solution of uric acid in a little more potassa ley than was necessary for the formation of neutral urate of potassa $2KO, C_{10} N_4 H_4 O_6$. The salt dissolves easily in the liquid, and is then directly changed into prussiate of potassa. After the first additions of red prussiate of potash, a separation occurred, of a thick, reddish white precipitate, by which all the liquid was soon thickened to a pulp; which on closer investigation, was found to consist of biurate of potash $KO, C_{10} N_4 H_4 O_6$. So much potash and red prussiate of potassa were alternatively added, that the uric acid remained in permanent solution. As soon as biurate of potassa separated, or as soon as the red prussiate of potash was undecomposed with facility, the addition of a few drops of potash ley were sufficient to renew the operation. The addition of red prussiate of potassa was continued till by a few drops of muriatic acid, no uric acid was precipitated. Towards the end of the operation, the decomposition of the uric acid proceeds slowly, and therefore the addition of red prussiate of potassa must be made at greater intervals.

The alkaline liquor which smells weakly of ammonia, and contains prussiate of potash, an excess of potash and the products of decomposition of uric acid, was then nearly neutralized with sulphuric acid, a considerable quantity of carbonic acid was disengaged, and the solution was evaporated by boiling; a constant smell of ammonia seemed to indicate a further decomposition of the generated organic bodies. The solution must not be perfectly neutralized with sulphuric acid, because then the prussiate of potassa is decomposed during the evaporation, prussic acid goes off and a white pulverulent combination $KFe_2 Cy_3$ precipitates itself, which it is nearly impossible to separate, because it goes through every filter.

The greater part of the prussiate of potash was separated by crystallization, the mother liquor was then evaporated to a small volume and mixed with alcohol, by which sulphate and prussiate of potash were precipitated; this precipitate was then boiled several times with alcohol to remove all substances soluble in the same. The alcoholic solution, during evaporation, gave crystalline crusts of an organic body, which having been separated, the liquor was concentrated to a syrup, and indicated after long standing, traces only, of indistinct crystals containing potassa. This syrupy mass was soluble in a great quantity of *weak*, and may be again precipitated in thick white flocks by *absolute* alcohol. The residuary salt mass extracted with alcohol consisted

mostly of prussiate and sulphate of potash to which no attention was paid. Other processes were followed to detect the organic substances insoluble in alcohol, which were possibly present.

A second portion of uric acid was treated as the first, except that the solution, which contained principally free potash, carbonate, and prussiate of potassa, and the organic bodies in research, was now neutralized with acetic acid under the precautions before mentioned. On evaporating, a quantity of acetate of ammonia was evolved. After the greater part of the prussiate of potash had crystallized, the separated mother liquor was likewise precipitated by alcohol, and then boiled out several times with the same. A previous essay to separate the prussiate of potash by means of acetate of copper, and an excess of the latter by sulphuretted hydrogen, did not furnish a favorable result, because complex decompositions took place, and sulphur entered into the composition of the organic bodies. The evaporated alcoholic solution which naturally contained a great quantity of acetate of potash, furnished not a trace of crystals, but only the above mentioned viscid syrup, which was separated from the acetate of potash by treating with absolute alcohol; this seemed to indicate that the first had sustained a further decomposition, by boiling with acetate of potassa, which conducts itself in many cases as a feeble alkali; the unmistakable development of acetate of ammonia furnished the proof of such decomposition.

The residuary salts, insoluble in alcohol, were then solved in water, and the prussiate of potassa precipitated from the hot solution by acetate of copper, only very slightly in excess; the filtrated solution contained, however, neither prussiate of potash nor copper salts, a proof that the small excess of acetate of copper was precipitated by the organic matter present. This filtrate treated with strong alcohol, afforded an abundant crystalline white precipitate, soluble in water, and crystallizing in well shaped crystals, which on farther investigation, proved to be *neutral oxalate of potash.* The presence of oxalic acid was further determined by the preparation and an analysis of oxalate of lead which furnished 75·16 oxyd of lead.

The purification of the previous mentioned crystalline substance was effected very easily by crystallization of the watery solution, for this substance is difficultly soluble in cold, but easily soluble in hot water, and crystallizes on cooling, in small, transparent, shining prisms; they have a neutral reaction, are easily soluble in alkalies and develop ammonia when the alkaline solution is heated. After neutralizing with acetic acid and addition of muriate of lime, an abundant precipitate of oxalate of lime is formed. A solution of the same body mixed with a small quantity of ammonia, gives a white precipitate with nitrate of silver. All these reactions pointed out *allantoin*, whose presence was perfectly confirmed by analysis.

To effect the analysis, air-dried crystals were burnt with chromate of lead:

1. 0·345 grammes substance gave 0·334 grammes carbonic acid and 0·109 grammes water.
2. 0·248 grammes substance gave 0·274 grammes carbonic acid and 0·092 grammes water.
3. 0·2321 grammes substance gave by combustion with soda-lime 1·2998 grammes platino-chlorid of ammonium = 0·08163 grammes nitrogen.

Calculated in per cents.:

	I.	II.	III.
Carbon,	29·91	30·13	. .
Nitrogen,	. .	. .	35·17
Hydrogen,	3·97	4·12	. .
Oxygen,	. .	. .	. .

These numbers represent exactly the composition of allantoin $C_4 N_2 H_3 O_3$ as results from the comparison of the calculated and found numbers:

	Calculated.		Found.
4C	24	30·37	30·02
2N	28	35·18	35·17
3H	3	3·79	4·04
3O	24	30·66	30·77
	79	100	100

The formation of ammonia and oxalic acid in heating and evaporating an alkaline allantoic solution, were now explained, for allantoin is decomposed perfectly into these two products, by boiling with alkalies; $C_4 N_2 H_3 O_3 + 3HO = 2$ equivalents $NH_3 \times 2$ equivalents $C_2 O_2$.

I have mentioned before that the alcoholic solution, filtrated from the allantoin, leaves by further evaporation, a sticky syrup containing potash, which, though easily soluble in water, can be separated by an addition of absolute or strong alcohol to the watery solution, as a thick, white flocculent precipitate. This precipitate collected on a filter, absorbs moisture with great avidity and deliquesces; as such it is not fit for analysis: I therefore tried to combine the organic body with oxyd of lead, and to analyze it as a lead salt. The watery solution of this substance, was for this purpose mixed with a solution of neutral acetate of lead, by which a sparse white precipitate was produced, consisting for the greatest part of oxalate of lead, which was filtered off. The liquid was then mixed in two fractions with pure ammonia, free from carbonic acid, by which a white, thick, curdy precipitate was formed; only the first precipitation was used for the entire analysis. Dried, this lead salt appeared as a white shining powder, insoluble in cold water and alcohol, little soluble in hot

water, easily soluble in acetic acid, and precipitable again by adding ammonia to this solution.

The amount of oxyd of lead was determined from the first and second precipitation, and it varied from 67–73 per cents., as probably this mode of precipitation occasioned the formation of more basic salts, wherefore, I was obliged to renounce the determination of the atomic weight of this body.

For the analysis, the lead salt was dried at 100° C.

1. 0·3127 grammes substance gave 0·2855 grammes sulphate of lead = 0·2100223 grammes oxyd of lead = 67·16 PbO.

2. 0·3455 grammes substance gave 0·3165 grammes sulphate of lead = 0·2328269 grammes oxyd of lead = 67·38 PbO.

3. 1·0433 grammes substance furnished by the combustion with chromate of lead, 0·3935 grammes carbonic acid and 0·1103 grammes water.

4. 0·949 grammes substance furnished by the combustion with chromate of lead, 0·3568 grammes carbonic acid and 0·10 grammes water.

5. 0·683 grammes substance furnished by the combustion with soda-lime 0·8512 grammes platino-chlorid of ammonia = 0·05345 grammes nitrogen.

In this case the relation of the atoms of oxyd of lead and carbon is 6 : 17, which proves clearly, that the determination of the lead in this salt is not decisive for establishing its atomic weight. If the mean amount of oxyd of lead 67·27 is subtracted, the following figures will express the composition of the combined organic body.

	I.	II.
Carbon, . . .	10·28	10·25
Nitrogen, ...	7·82	7·82
Hydrogen, . . .	1·18	1·15
Oxygen, ...	19·22	19·15

From these values the following formula may be deduced, showing exactly the composition of the organic substance which has been combined with oxyd of lead:

$$C_6 N_2 H_4 O_6.$$

The results of the comparison of the found and calculated values expressed in per cents., is as follows:

	Calculated.		Found.	
			I.	II.
C_6	36	31·03	31·40	31·31
N_2	28	24·13	23·89	23·89
H_4	4	3·44	3·60	3·51
O_6	48	41·40	41·11	41·29
	116	100	100	100

This body is a new acid for which I propose the name of *lantanuric acid;* I shall have an opportunity in the course of this paper to return to this subject.

After the presence of allantoin was proved by analysis, it was clear that in the adopted way it was impossible, to study the process of oxydation of uric acid here occurring, because the action of a hot alkaline solution on the generated products so easily occasions secondary decompositions. Hence I adopted a new mode for the decomposition of uric acid, and carefully avoided everything which could possibly occasion a decomposition of the newly generated allantoin.

The solution of uric acid in potassa ley was obtained as before; and to this, an alkaline solution of 5 oz. uric acid in one gallon of water at 20° C. was added alternately for some time; also ferridcyanid of potassium and potash ley till all uric acid was completely decomposed: to effect this, there were necessary 20½ oz. red prussiate of potash and 10¼ oz. hydrate of potash, which is expressed in equivalents nearly exactly:

1 equivalent of uric acid $C_{10}N_4H_4O_6$.
2 " of ferridcyanid of potassium.
6 " of hydrate of potassa.

Thus there are only two equivalents of oxygen combined with one equivalent of uric acid. The alkaline solution was mixed with pure nitric acid nearly to neutralization, a great quantity of carbonic acid developed itself, although the hydrate of potassa originally employed in this essay was freshly made and nearly free from carbonic acid, and as far as possible I had prevented the absorption of carbonic acid from the air. The solution became turbid and colored soon after the neutralization, (the same takes place when instead of *nitric* acid, carbonic acid is used for the neutralization of the free alkali,) and after a short time, a small quantity of a light flocculent dirty brick-colored precipitate separated, and nearly at the same time, allantoin began to form in crystals from the liquid. The perfect separation of this red flocculent precipitate took place after 3 or 4 days, and the liquid then assumed the ordinary yellow color of a concentrated solution of prussiate of potash; the crystallization of the allantoin required 8–10 days.

After the separation of allantoin and the red body by filtration, the filtrated liquor was mixed with nitric acid, till a strong acid reaction occurred, and then, all prussiate of potash was precipitated by a solution of nitrate of lead, the prussiate of lead being insoluble in very diluted nitric acid, while the precipitation of an organic lead salt was thus perfectly prevented. After the separation of the prussiate of lead, and the precipitation of a small excess of lead oxyd by means of sulphate of potassa, the solution was then perfectly neutralized with potassa, after which operation it

could only contain nitrate of potassa and the problematic organic substances. Oxalic acid was not present. The nitrate of potassa was separated for the greatest part, including a small portion of allantoin still present, by evaporation and crystallization. The mother liquid concentrated to a small volume, was then mixed with cold absolute alcohol; by means of which was precipitated the greatest part of the still present nitrate of potassa, with a small portion of the before mentioned viscid body (lantanurate of potassa). The filtrated alcoholic solution was then evaporated to dryness in the water-bath. The very small crystalline residue, soluble in water and mixed with concentrated nitric acid, a crystallization of *nitrate of urea*, characteristic in its form, instantly took place; the whole amount of it, did not exceed two to three grammes. The identity of nitrate of urea ($C_2 N_3 H_5 O_8$) was rendered unquestionable by means of a combustion analysis with oxyd of copper.

This substance thus furnished in five tubes, a relation of carbonic acid and nitrogen as 2 : 3 or together as 42, 2C . C CO_2 : 66, 1CC N.

The quantity of the appearing urea is too small to allow the idea, that it proceeded from the direct oxydation of the uric acid. I consider it as a secondary product of the decomposition of a small portion of allantoin; I shall show hereafter, the latter suffers an alteration in an alkaline solution; two equivalents of allantoin take in their composition, two equivalents of water, and form with it an easily decomposable new acid $C_8 N_4 H_8 O_8$; this acid separates most probably into urea and lantanuric acid by a longer contact, or heating with alkalies.

$$C_8 N_4 H_8 O_8 \begin{cases} C_6 N_2 H_4 O_6 = \text{lantanuric acid.} \\ C_2 N_2 H_4 O_2 = \text{urea.} \end{cases}$$

The above mentioned red flocculent body appears likewise in too inconsiderable a quantity, to be deemed other than a secondary product of this new method of decomposing uric acid; the only products, which appear in notable quantity, are allantoin and carbonic acid. I have mentioned before that two equivalents of ferridcyanid of potassa, were necessary to effect the decomposition of one equivalent of uric acid; thus one equivalent of uric acid has taken up two equivalents of oxygen; it needs now only two equivalents of water in addition, to allow of its separation into two equivalents of allantoin and two equivalents of carbonic acid. This simple decomposition of uric acid takes place by this process of oxydation. 1 equiv. uric acid + 2 equiv. ferridcyanid of potassa + 4 equiv. potassa + 2 equiv. water, form 4 equiv. of prussiate of potassa, 2 equiv. of carbonate of potassa and 2 equiv. of allantoin.

1 eq. uric acid	$C_{10}N_4H_4O_6$	2 eq. allantoin	$C_8N_4H_6O_6$
2 " oxygen	O_2	2 " carb. acid	C_2O_4
2 " water	H_2O_2		
	$C_{10}N_4H_6O_{10}$		$C_{10}N_4H_6O_{10}$

The excess of potassa served on the one part to hold in solution the resulting allantoin, and on the other part, to accelerate the decomposition.

I have not submitted the above mentioned red flocculent substance, to a farther investigation, because the quantity of it was very small, and I did not succeed in separating this body perfectly from prussiate of potash and allantoin; the reactions made with it show, nevertheless, that it is a new and certainly an interesting body. It has nearly the same solubility in cold and hot water and alcohol, as allantoin, and it could be obtained only in small quantity washing the latter, and filtering off. This red substance gives to water and alcohol a rich orange color; is easily soluble in hot water, by which means the color changes however to light yellow, and in cooling, the watery solution deposits a fine sulphur-yellow precipitate; a great part remains however in solution. In potassa ley and ammonia, this red body is soluble with an orange color; but after addition of an acid, only a small portion of it separates with a light yellow color. In boiling the alkaline solution, ammonia is formed, and acids added to the nearly colorless solution cause no further precipitate.

The quantity of the crystallized allantoin is very great, so that, if an easy mode of separating the red body adhering so obstinately to it, should be found out, this process would furnish perhaps the most advantageous mode of preparing it.

I succeeded after many essays by the following way, but with great loss, in obtaining allantoin in perfect purity. Relying on the statement of Liebig and Wöhler, that cold potash ley did not exert any decomposing action on allantoin, the brick-colored allantoin separated as well as possible, by means of water, from the prussiate of potassa, was dissolved in concentrated cold potassa ley, which was very easily effected; after filtration the orange-colored alkaline liquor was directly mixed with acetic acid, till an acid reaction; a slight yellow turbidness resulted, occasioned by the red body, and soon afterwards allantoin began to deposit itself in small nearly white crystals. By often repeated crystallization from hot water, it was obtained perfectly pure in white, shining, transparent, prismatic crystals.

By this mode of purifying allantoin, a great part of it remains behind in the solution of acetate of potassa which cannot be obtained by evaporation; on the contrary, a great quantity of acetate of ammonia goes off, indicating a new decomposition. The solution in acetate of potassa, filtrated from allantoin, was con-

centrated to a syrup, in the water-bath, and then mixed with a great volume of absolute alcohol; by which a thick flocculent nearly white precipitate of an organic potash combination resulted. The alcoholic solution was filtered off from it, and evaporated to dryness; the residue consisted chiefly of acetate of potassa scarcely mixed with other organic substance; oxalic acid and urea were not found. The flocculent substance precipitated by alcohol was solved in a small quantity of water, and only a few drops were sufficient, to convert it into a syrup; after all reactions, it seemed to be perfectly identical with the above mentioned impure lantanurate of potassa. The solution had an acid reaction, and afforded with acetate of lead an abundant white precipitate, in every respect like the lantanurate of lead, already described. This solution ought to contain neutral, or acid lantanurate of potassa; hence the following way was chosen to obtain one of these potassa combinations fit for analysis. The syrup-like watery solution was very cautiously mixed with alcohol, till a slight turbidness presented itself, indicating the precipitation of the potassa salts. The weak alcoholic solution was then left to itself; by and by, after a long time, crystals and crystalline crusts began to deposit; from time to time a new quantity of alcohol was added by which a new impulse was given to the crystallization. Finally, the crystallization terminated; whereby the liquid became more and more neutral, and lost its acid reaction.

The separated crystals were *bilantanurate of potassa*, as will be seen by the result of the following analysis. They were purified by repeated crystallization out of water; and the attached yellow coloring matter became by and by insoluble, and could be separated by filtration.

The pure bilantanurate of potassa crystallizes out of the watery solution in hard crystalline crusts, which consist of an aggregation of very strong shining white tabular crystals; it is soluble in 8–10 parts of cold, and in much less hot water, but it very slowly crystallizes out of the hot saturated solution when cooled; it is insoluble in strong alcohol. I added a small quantity of alcohol to the watery solution, and it directly became milky; but after a short time it cleared up again, and the bilantanurate of potash deposited itself in small dazzling white voluminous acicular crystals. The solution of this salt gives with acetate of lead no precipitate; but after addition of alcohol, there results a thick perfectly white precipitate, which disappears again after addition of more water; probably it is bilantanurate of lead, which is after this easily soluble in water and insoluble in alcohol; there also results a thick white flocculent precipitate of lantanurate of lead, if ammonia is added to a mixture of bilantanurate of potassa and acetate of lead, or if the former is precipitated with basic acetate of lead. With nitrate of silver on the addition of

ammonia, a thick white precipitate of lantanurate of silver results, which is not changed by boiling. If bilantanurate of potash is neutralized with potash and evaporated, the solution dries without any signs of crystallization to a viscid syrup, precipitable by alcohol in flocks; by the addition of stronger acids, the acid potassa salt could not be recrystallized. The thick mother-liquor filtered from the impure bilantanurate of potassa, seemed to consist principally of the neutral potassa salt, mixed with a small portion of another substance which could be separated by acetate of lead, as a white precipitate insoluble in acetic acid.

The salt employed for analysis was perfectly pure, and crystallized in small dazzling rhombic plates.

(1) 0·135 grammes of the air-dried salt, gave 0·355 grms. sulphate of potash = 0·0191937 grms. potassa, or 14·22 per cent. KO. From these numbers the atomic weight is = 331·9.

(2) 0·4815 grms. of the air-dried salt, gave by combustion with chromate of lead, 0·400 carbonic acid and 0·1775 grms. water.

(3) 0·2607 grms. of the air-dried salt, gave 0·816 grms. Plat. chl. ammonium = 0 05189 grms. nitrogen.

From the found numbers, the empirical formula of this salt is $KO, C_{12} N_4 H_{13} O_{17}$, which is equal to:

$$KO, C_6 N_2 H_4 O_6, C_6 N_2 H_4 O_6 HO, + 4aq.$$

Atomic weight:

			Calculated.		Found.
1	Equiv.	KO	47·2	14·55	14·22
12	"	C	72	22·20	22·65
4	"	N	56	17·27	17·47
13	"	H	13	4·01	4·09
17	"	O	136	41·97	41·57
			324·2	100·	100·

This formula was perfectly confirmed by a direct determination of the water of crystallization.

0·2934 grms. of the air-dried salt, lost at 100° C., 0·0327 grms. water, which corresponds exactly to 4 equivalents of water.

			Calculated.	Found.
1	Equiv.	$KO, C_6 N_2 H_4 O_6$	50·33	. .
1	"	$C_6 N_2 H_4 O_6 HO$	38·57	. .
4	"	HO	11·10	11·15
			100·	

The bilantanurate of potash dried at 100° C., has then the following composition:

$$KO, C_6 N_2 H_4 O_6, C_6 N_2 H_4 O_6 HO.$$

The composition of lantanuric acid is equal to $C_6 N_2 H_4 O_6 HO$. The dehydrated acid can be considered as consisting of $2Cy + C_2 HO_3 + 3HO$, or as urea +4 equiv. of carbonic oxyd; it has one equivalent of oxygen more than murexan and difluan.

Its formation from allantoin is very simple; the latter takes up 2HO in contact with alkalies, as already mentioned, and forms the new acid $C_8 N_4 H_8 O_8$, which divides itself on farther contact with alkalies into urea and lantanuric acid. I mentioned that by the investigation of the solution, which was filtered out from the allantoin, and consisting principally of prussiate of potash, lantanuric acid and urea were detected.

I have tried to separate the lantanuric acid from the lead-salt by means of sulphuretted hydrogen. It forms an acid solution, which dries to a gum-like mass, uncrystallizable in water and alcohol. The quantity was however too small, to allow me to make further researches with it. Farther, I have prepared the silver salt from the potash salt, by means of neutralization with ammonia and separation by nitrate of silver, which caused a thick white precipitate. The lantanurate of silver was dried at 100° C., and was just sufficient for a determination of its atomic weight.

0·2645 grms. salt gave 0·140 grms. silver = 0·15097 grms. oxyd of silver. The atomic weight of this combination hence as calculated = 204. The atomic weight of the organic substance combined with silver consequently = 88. Expressed by a formula, the composition of this silver salt is thus:

$$Ag\,O,\ C_6 N_2 HO_3.$$

Calculated in per cents.:

	Calculated.		Found.
1 Equiv. Ag O	116	56·61	56·84
1 $C_6 N_2 HO_3$	89	43·39	. . .

Thus by drying the lantanurate of silver at 100° C., three equivalents of water have been removed from lantanuric acid. From the composition of the bilantanurate of potash and of the lantanurate of lead dried at 100°, it is however probable that in the analyzed silver salt, the lantanuric acid was not present as such; nevertheless, the composition of lantanuric acid must be expressed by the formula $C_8 N_2 H_4 O_6$, HO.

I had not enough of the substance to permit an analysis of the lantanurate of silver in an air-dried state, or to ascertain whether bilantanurate of potash or lead will still give off water at a high temperature without change of its other qualities.

If a strong acid is added immediately to pure allantoin dissolved in cold concentrated potassa ley, nearly the whole quantity of this substance precipitates, if the alkaline liquor stands a long time. The quantity of allantoin precipitated is smaller and smaller, and after one or two days (in summer), all the allantoin is changed, and acids no longer precipitate that substance. If the solution is now boiled, only a small quantity of ammonia is evolved, and no oxalic acid is formed; hence no allantoin is present. If

the colorless alkaline liquor is neutralized with acetic acid till an acid reaction, and then alcohol be added, the liquid becomes milky and clears again very soon, because the potash combination of the new formed acid separates itself at the bottom of the vessel as a concentrated, clear, oily liquid. All attempts to get the potash salt in a crystalline form failed; mixed with water, it gives an abundant white precipitate with nitrate of silver, becoming black on boiling. To estimate the combination of this new acid, to which may be given the name hydallantoinic acid, I used a lead salt. Allantoin was solved in cold concentrated potash ley; after two days standing neutralized with acetic acid till an acid reaction, there was then added to it a solution of acetate of lead; the liquid remained at first clear; but very soon the walls of the vessel were coated with a light white precipitate of a peculiar form, and the liquid became very soon troubled with a thick flocculent, dazzling white voluminous precipitate of the new lead salt, which quickly deposited itself and was easily washed out. The precipitate presented after drying, a white light powder easily soluble in acetic acid, even on boiling with it.

The lead salt dried at 100° C. was analyzed:

1. 0·3745 grm. substance gave 0·199 grm. sulphate of lead = 0·1464 grm. oxyd of lead; atomic weight = 286.

2. 0·286 grm. substance gave 0·153 grm. PbO, SO_3 = 0·1126 grm. PbO; atomic weight = 284.

3. 0·449 grm. substance gave by combustion with soda-lime 1·3635 grm. Plat. chl. ammon. = 0·08552 grm. nitrogen.

4. 0·5275 grm. substance gave, burnt with oxyd of copper, 0·324 grm. carbonic acid and 0·138 grm. water.

From these numbers, the following formula for the hydallantoinate of lead may be calculated:

$$PbO, C_8 N_4 H_6 O_6$$

as the comparison of found and calculated numbers shows.

	Calculated.		Found.	
1 equiv. PbO	112	38·79	39·09	39·37
8 " C	48	16·69	16·75	. .
4 " N	56	19·47	19·04	. .
8 " H	8	2·77	2·90	. .
8 " O	64	22·28	22·22	. .

This new acid thus results from allantoin by taking up two equivalents of water.

2 equiv. of allantoin $= C_8 N_4 H_6 O_6$
2 " " water $= H_2 O_2$

1 equiv. of hydallantoinic acid $= C_8 N_4 H_8 O_8$.

By treating with sulphuretted hydrogen, this acid could be removed from the lead salt as a colorless solution of a very acid

taste; it could also be obtained, by decomposing the lead salt with sulphuric acid.

The acid was evaporated in a water-bath to a thick syrup, which could not be crystallized; the same was precipitated by absolute alcohol, (in which the acid, and as it seems the salts of it, are insoluble,) as a white brittle mass, which however very soon, attracted moisture again, and deliquesced; mixed with cold potash ley, ammonia was given off, and evaporated, insoluble flocks separated; mixed with a drop of ammonia, and adding nitrate of silver, a white precipitate resulted, which dissolved for the greatest part by heating. With baryta water there was no precipitate; but after the addition of alcohol a flocculent white precipitate, again disappearing after addition of water. Neutralized with ammonia and evaporated in the water-bath, ammonia escapes, and the solution retakes again its acid reaction; with chlorid of barium under addition of ammonia there is a white precipitate; with acetate of lead, a thick white precipitate; mixed with carbonate of soda or potash, no carbonic acid was given off; on heating, the alkaline solutions became turbid with separation of white flocks. These reactions, and principally the behavior with alkalies and silver, indicated that this acid had suffered already an alteration during evaporation by the heat; nevertheless the silver salt was prepared from it, dried at 100° C. and analyzed; the amount of oxyd of silver was found to be 45·31, and by combustion with soda-lime were obtained 13·12 nitrogen; these numbers give a relation of equivalents of oxyd of silver to nitrogen nearly as 2 : 5, which proves clearly, that an alteration of the acid had taken place.

I did not follow this subject farther, because it was less my intention to investigate the products of decomposition of allantoin, than to study the process of oxydation of uric acid by means of ferridcyanid of potassium and caustic potash. The similarity of these products, obtained by decomposition of allantoin, with the allanturic acid obtained by Pelouze from the decomposition of allantoin by acids, is not questionable; but a comparison of the analytical results was not possible, because in the paper of Pelouze on this subject, only the formula without the details of analysis were given.

I cannot conclude without expressing my thanks to my friend Professor Horsford, for kindly tendering to me the use of his Laboratory and apparatus for the completion of a few experiments unfinished in Europe.

Lowell, July 13th, 1848.

Art. XXXVI.—*New Mexico and California.*

At the last Session of Congress there were four Reports presented relating to Northern Mexico.

I. Memoir of a Tour to Northern Mexico, connected with Colonel Doniphan's Expedition in 1846 and 1847; by A. Wislizenus, M.D.

II. Notes on a Military Reconnaissance from Fort Leavenworth in Missouri, to San Diego in California; by Brevet Major W. H. Emory.

III. Report and Map of the Examination of New Mexico; by Lieutenant J. W. Abert.

IV. Geographical Memoir upon Upper California; by J. C. Fremont.

The last of these four Reports is briefly noticed on page 280 of this volume. We offer here an abstract of such information from the others as relates to the structure and resources of the country.

Dr. Wislizenus was physician to Colonel Doniphan's column. His object in visiting Mexico and California was scientific; and with this end in view, the rocks, mines, and plants of the region were carefully studied, and many important acquisitions to science were made. It had been his intention to travel in a private expedition; but the war with Mexico commencing, his plans were frustrated. After a detention of six months, Dr. Wislizenus accepted a situation in the medical department of the army, and was thus enabled to accomplish in part the main object of his projected tour.

The route led from Independence, Missouri, near latitude 39° N., and longitude 94° 20′ W., by Council Grove, (long. 96° 40′) to Osage Camp on the Arkansas (long. 98½° W.); thence along the Arkansas to a few miles beyond the Pawnee Fork (98° 55′ W.), Fort Mann (100° 10′ W.); here crossing the Arkansas and passing south of west to the banks of the Cimarron, and thence onward by a track leading to the southeast of the Raton mountains, crossing in succession Cedar Creek, McNees Creek, Cottonwood Creek, Rabbit Ear Creek, (head waters of the Rio Nutria,) then more southeasterly, passing Rock and Whetstone Creeks and the head waters of the Colorado, to St. Miguel, and around to Santa Fe, (35° 41′ N., 106° 2 W.) From Santa Fe, which is on a small stream near the Rio del Norte, within one hundred and fifty miles of the head of the latter, they followed down to El Passo del Norte, (32° 15′ N.) thence south to Chihuahua (29° 20′ N.), and Cadena (26° 10′ N., 104° 40′ W.), thence south of west to Saltillo, (101° W.) and west to Monterey and Matamoras. The author gives the following account of the rocks observed in the course of his journeyings.

The geological sketch which I have drawn, [alluding to a map accompanying the Report,] does not make any pretensions to a geological map, which even a more able geologist than I am could not give in the short time and haste, in which I travelled through that country: but it may elucidate and concentrate at least what little information I have acquired in relation to that subject. To make it more intelligible, I will add a short summary of the various geological observations spread over the whole extent of the journal.

Independence, near the western frontier of the State of Missouri, is situated in the great Missouri coal basin, which occupies more than one-third of that State.

The first rock in situ which I saw in the prairie, after leaving Independence, was on Rock creek, (about 79 miles from Independence.) It was a yellowish-brown compact limestone, with encrinites and similar fossils of the carboniferous limestone, to those found in Missouri.

On Pleasant Valley creek (125 miles) the bluffs are formed of two different limestones: one is white and compact; the other grayish, soft, and argillaceous. The first contained some indistinct fossils, but in too imperfect a state to determine what formation they indicate.

In Council grove (143 miles) a horizontal, grayish, argillaceous limestone prevails, without fossils.

Leaving Cottonwood creek, (185 miles,) irregular heaps of bog-ore are seen in the prairie, and a ferruginous sandstone of yellow, brown, and blue colors, extends from here to Pawnee fork, (a distance of about 100 miles.)

The bluffs of the Little Arkansas, consisted of a spotted, yellow, calcareous sandstone, and isolated pieces of ferruginous sandstone.

Between Camp Osage (the first camp near the Arkansas river) and Walnut creek, (263 miles,) I met with a very porous and scoriaceous rock in situ, apparently the product of action of subterranean fires upon the ferruginous sandstone. Most likely a large coal-field lying beneath here, has become ignited, and produced this change of the rock. The so-called Pawnee rock (between Walnut creek and Ash creek) consists of the same ferruginous sandstone, changed by fire. On Pawnee fork (292 miles) I saw the last of it; the ferruginous sandstone there was more compact, and deep red.

On a branch of Big Coon creek, (332 miles,) I found the bluffs to consist of common sandstone below, and a white, fine-grained marl above it. This marl resembles very much some from the cretaceous formation of the Upper Missouri; but finding no fossils, I could not ascertain the fact regarding it.

Two miles beyond that place, (341 from Independence,) I had the first chance to examine the bluffs on the Arkansas; the rock was a grayish, conglomerate limestone, with a few small fossils, that were rather imperfect, but seemed to belong to the cretaceous formation. The neighborhood of the above mentioned marl raises this presumption nearly to certainty. I have, therefore, not hesitated to lay it down as cretaceous formation. About 20 miles higher on the Arkansas, I saw, upon a second examination, only a coarse conglomerate of sand and limestone. At the usual fording place (373 miles) where I left the Arkansas for the Cimarron, no rocks in situ were visible.

Having crossed the Arkansas, I met with the first rocks again, on the "middle springs of Cimarron," (468 miles;) it was a sandy limestone above common sandstone.

Six miles west of the Crossing of Cimarron, (500 miles from Independence,) light bluffs rise in the prairie, of a yellow, reddish, and spotted sandstone, combined with lime and argile.

A few miles beyond them, a large isolated mountain of boulders stands in the plain, composed of heavy blocks of quartz and quartzose sandstone, and many erratic rocks were afterwards found on our road.

On Cedar creek, McNees' creek, and Cottonwood branch, a yellow sandstone prevailed.

On Rabbit-ear creek I met for the first time with amygdaloidal basalt, a black, heavy, basaltic rock, with a great many irregular, vesicular cavities, that are generally hollow—but sometimes, filled with lime; in rare instances, with olivine. This rock is very common throughout the high mountains of Mexico. It occurs in irregular masses, and in whole mountains, as well as in millions of pieces strewn over the surface of the country. Here it rose in high perpendicular walls, as bluffs of the creek, and a very compact quartzose sandstone was below in horizontal layers.

The round mound, a mountain in the prairie about three miles farther west, which I ascended, is formed of a brown, decomposed basaltic rock.

On Rock creek, and Whetstone creek, amygdaloidal basalt with underlying sandstone was found.

In going from there to "Point of Rocks," (600 miles,) extensive strata of a yellow, compact quartzose sandstone were passed, dipping gently towards the east. Point of Rocks itself, a spur of the western mountains, is a mass of syenite.

Some twelve miles beyond it, rises a hill in the plains, composed of very compact, black basalt, with underlying white sandstone.

The bed and bluffs of the Rio Colorado and Ocaté creek, (627 miles,) are formed by quartzose sandstone.

The Wagon mound, an isolated mountain in the high plain, consists of a compact, black, and spotted basalt, rising in columnar shape.

On Wolf creek, (664 miles,) the amygdaloidal basalt and quartzose sandstone reappeared, both in horizontal layers.

Reaching the Gallinas creek, near Las Vegas, (690 miles,) I met, after a long interval, with limestone again. It was a dark blue, with casts of Inoceramus of the cretaceous series.

From here we penetrated into the very heart of the mountains. At first we met with sandstone alone, common and quartzose, and of various colors.

Near San Miguel, (707 miles,) a coarse conglomerate was found of decomposed granite, sandstone, and lime; and large blocks of decomposed granite lined the Pecos river, opposite the old Pecos village, (737 miles.)

In the cañon leading from here to Santa Fe, at first sandstone was found, common, quartzose, and calcareous, of various colors and granulations, till about fifteen miles from Santa Fe, granite in situ appears, and continues all the way to Santa Fe. Near where I met for the

first time with granite in situ, the sandstone, if I may judge from a very limited examination, was suddenly uplifted and thrown back at an angle of nearly one hundred degrees.

West of Santa Fe, granite seems also to prevail. In my excursion to the Placers, southwest of Santa Fe, I found sandstone below, and on the height of the mountains granite and trap rocks.

In the mountains of that neighborhood common limestone and sulphate of lime are said to exist; but on the road over which I travelled I had no opportunity to see any.

Granitic and trap formations seem to predominate, too, in the valley of the Rio del Norte below Santa Fe; but as the road leads always along the river, and the mountains on either side are generally about ten miles distant, I could not examine them as I wished to do, and had often to depend upon the external form of the mountain chain, which apparently indicated unstratified and igneous rocks. Whenever the mountains approached the river, I gained more information. Thus, for instance, I found between Joyita and Joya, (above 115 miles from Santa Fe,) quartzose sandstone and quartz in a spur of the eastern mountain chain; and in Joyita itself, bluffs near the river, of amygdaloidal basalt.

Some miles west of Socorro, (140 miles,) on the right bank of the river, I examined the western mountains, and found porphyritic and trachytic rocks.

Near the ruins of Valverde, (165 miles,) I met with bluffs of a dark brown, nodular sandstone; and about eight miles beyond, with amygdaloidal basalt again.

In the Jornada del Muerto, granitic and basaltic formations, to judge from their shape, exist in the distant mountain chains; part of them in the eastern chain is called, from the basaltic appearance, Organ mountains.

Below Doñana I perceived some primitive rocks again, near the river, resembling a decomposed porphyry.

The mountains above El Paso belong mainly to the trap formation.

During my short stay in El Paso I made an excursion to the southwestern mountains of the valley, and was rather astonished to find mountains of limestone. The foot of the mountains was formed by a horizontal quartzose sandstone, similar to that underlying the amygdaloidal basalt. The very compact and gray limestone, intersected with many white veins of calc spar, rose upon it to the crest of the mountains; but in several places, granite and greenstone seemed to have burst through it and formed partial eruptions. After a long search I discovered some fossils, and though much injured and imperfect, they are nevertheless sufficient to determine the age of this formation. The fossils are a coral (*Calamopora*), and a bivalve shell of the genus *Pterinea*. This limestone is therefore a Silurian rock. Several mines have formerly been worked in it.

On the road from El Paso to Chihuahua I met in the first day or two with the same limestone. The pieces lying on the road were generally surrounded with a white crust of carbonate of lime; pieces, too, of what appeared to be fresh-water limestone, occurred. It is rather probable that this is the same material with the white crust of the blue limestone, and that both are the result of calcareons springs.

About fifty miles south of El Paso the limestone seemed to cease, and porphyritic rocks of the most varied colors and combinations continued from here as far as Chihuahua, interrupted sometimes only by granitic rocks. The base of the porphyry is generally feldspar.

Around Chihuahua and some distance to the south and west of it, in the Sierra Madre, porphyritic rocks predominate, and valuable mines are found in them.

Near Chihuahua, as I understood, about twelve miles northeast of it, mountains of limestone appear; and through the favor of Mr. Potts, in Chihuahua, I received a piece of limestone from there, containing some casts of the chambers of an Orthoceras, proving that this limestone belongs also to the Silurian system. Mines are also found in it.

Another fossil I received in Chihuahua, said to come from the limestone near Corralitas, a mining place about 250 miles northwest of Chihuahua. It is a Pecten quinquicostatus, (Sowerby,) of the cretaceous series; but not having travelled through that part of the state, I am not able to give any comment upon it.

From Chihuahua to Matamoras, travelling with the army as a surgeon, my time was so occupied that I could not make any distant excursions from the road; generally, the geology of the country seemed to be very uniform and uninteresting.

From Chihuahua some distance south, porphyritic rocks continued. In Saucillo, (70 miles from Chihuahua,) I perceived the first limestone again. From there to Santa Rosalia I passed some hills of amygdaloidal basalt, but the main chain of the mountains was all limestone, and continued to be so throughout the whole eastern ramification of the Sierra Madre, over which we travelled from here down to Saltillo and Monterey, where the low country begins. This limestone forms steep, often rugged mountains, rising on an average 2,000 feet above the plain; it is metalliferous, and has all the appearance of the Silurian limestone, found at El Paso and Chihuahua, but I was never able to discover any fossils on this route. Silver and lead mines are of various occurrence in it; in the limestone surrounding Cadena, coal has been found, as I was informed, but I had no time to verify it.

From Monterey to the seashore I made one interesting discovery near Mier. On the bank of the Alamo river, about four miles above its mouth into the Rio Grande, I found an extensive bed of large fossil shells of Ostrea, belonging to the cretaceous formation. As the same formation has lately been found by Dr. Rœmer, of Berlin, to extend in Texas from the San Antonio to the Brazos, this cretaceous bed near Mier is in all probability a continuation of it. In looking over the recent publication of "Notes of the upper Rio Grande, by Bryan Tilden," I found in a description of the river bank of the Rio Grande below Laredo, that "entire hills are to be seen, composed almost wholly of what appears to be a collection of large sea oyster shells." I presume, therefore, that the same cretaceous formation extends in this direction higher up on the Rio Grande.—pp. 135–138.

In farther illustration of the country we cite some paragraphs from other parts of the Report.

Council Grove forms, as it were, a dividing point in the character of the country east and west of it. The country east of it is formed of prairie, with slight ascents and descents—constant undulations, as I might call them; sometimes shorter and more rapid; sometimes larger and fuller, resembling the waves of the ocean, which no doubt once covered those plains, and partly moulded their present form. Of those slight undulations, the barometrical measurements will give evident proof. Big Blue Camp is elevated 1,020 feet above the sea; Council Grove is 1,190; and the highest intermediate point is 1,420 feet, on the divide between the waters of the Osage and the Neosho or Grand river. This eastern portion is well watered, and along the water-courses sufficiently timbered to sustain settlements. The soil is generally very fertile, and, to judge from the higher elevation, more exempt from fevers, the plague of the bottom-land. Let us take a prospective view now of the country west of Council Grove. A short distance west, the country rises suddenly to the elevation of 1,500 feet, and ascends gradually towards the Arkansas to 2,000 and more feet above the sea. The intermediate country exhibits sometimes the short, wavelike form of the eastern portion, but oftener it already resembles the plateaux or high plains between the Arkansas and Cimarron, those representatives of the calm immense high seas, where the horizon extends farther, the soil becomes dryer and more sandy, the vegetation scantier, timber and water more rare. The country between Council Grove and the Arkansas forms the transition to the sandy plains on the other side of the Arkansas; the soil is generally less fertile than in the eastern portion, but all along its water-courses (as Cottonwood creek, Little Arkansas, Walnut creek, Ash creek, Pawnee fork, and the Arkansas) settlements might succeed, though they would have to depend more upon stock-raising than agriculture.—p. 7.

New Mexico is a very mountainous country, with a large valley in the middle, running from north to south, and formed by the *Rio del Norte*. The valley is generally about twenty miles wide, and bordered on the east and west by mountain chains, continuations of the Rocky mountains, which have received here different names, as Sierra blanca, de los Organos, oscura, on the eastern side, and Sierra de los Grullas, de Acha, de los Mimbres, towards the west. The height of these mountains south of Santa Fe may be, upon an average, between six and eight thousand feet, while near Santa Fe, and in the more northern regions, some snow covered peaks are seen that may rise from 10,000 to 12,000 feet above the sea. The mountains are principally composed of igneous rocks, as granite, syenite, diorite, basalt, &c. On the higher mountains excellent pine timber grows; on the lower, cedars, and sometimes oak; in the valley of the Rio Grande, mezquite.

The main artery of New Mexico is the Rio del Norte, the longest and largest river in Mexico. Its headwaters were explored in 1807 by Captain Pike, between the parallels of 37° and 38°; but its highest sources are supposed to be about two degrees farther north in the Rocky mountains, near the headwaters of the Arkansas and the Rio Grande, (of the Colorado of the west.) Following a generally southern direction, it runs through New Mexico, where its principal affluent is the Rio Chamas from the west, and winds its way then in a south-

eastern direction through the states of Chihuahua, Coahuila and Tamaulipas, to the Gulf of Mexico, in 25° 56′ north latitude. Its tributaries in the latter states are the Pecos, from the north; the Conchos, Salado, Alamo, and San Juan, from the south. The whole course of the river, in a straight line, would be near 1,200 miles; but by the meandering of its lower half, it runs at least about 2,000 miles from the region of perpetual snow to the almost tropical climate of the gulf. The elevation of the river above the sea near Albuquerque, in New Mexico, is about 4,800 feet; in El Paso del Norte about 3,800; and at Reynosa, between three and four hundred miles from its mouth, about 170 feet. The fall of its water appeared to be, between Albuquerque and El Paso, from two to three feet in a mile, and below Reynosa one foot in two miles. The fall of the river is seldom used as motive power, except for some flour mills, which are oftener worked by mules than by water. The principal advantage which is at present derived from the river is from agriculture, by their well managed system of irrigation. As to its navigation in New Mexico, I doubt very much if even canoes could be used, except perhaps during May or June, when the river is in its highest state, from the melting of the snow in the mountains. The river is entirely too shallow, and interrupted by too many sand bars, to promise anything for navigation. On the southern portion of the river the recent exploration by Captain Sterling, of the United States steamer, Major Brown, has proved that steamboats may ascend from the gulf as far as Laredo, a distance of seven hundred miles. Although this steamboat did not draw over two feet of water, yet the explorers of that region express their opinion, that "by spending some $100,000 in a proper improvement of the river above Mier, boats drawing four feet could readily ply between the mouth of the Rio Grande and Laredo." Whenever a closer connexion between the headpoint of navigation and New Mexico shall be desired, nothing will answer but a railroad, crossing from the valley of the Rio Grande to the high table land in the state of Chihuahua.

The *soil* in the valley of the Rio del Norte, in New Mexico, is generally sandy and looks poor, but by irrigation it produces abundant crops. Though agriculture is carried on in a very primitive way, with the hoe alone, or with a rough plough, made often entirely of wood, without any particle of iron, they raise large quantities of Indian corn and wheat, beans, onions, red peppers, and some fruits. The most fertile part of the valley begins below Santa Fe, along the river, and is called "Rio abajo," or, (the country) down the river. It is not uncommon there to raise two crops in one year. The general dryness of the climate, and the aridity of the soil in New Mexico, will always confine agriculture to the valleys of the water-courses, which are as rare here as over all Mexico—such, at least, as contain running water throughout the year. But this important defect may be remedied by Artesian wells. On several occasions I remarked on the high table-land from Santa Fe south, that in a certain depth layers of clay are found, that may form reservoirs of the sunken water-courses from the eastern and western mountain chain, which, by the improved method of boring, or Artesian wells, might be easily made to yield their water to the surface. If experiments to that effect should prove

successful, the progress of agriculture in New Mexico would be more rapid, and even many dreaded "Jornadas" might be changed from waterless deserts into cultivated plains. But at present, irrigation from a water-course is the only available means of carrying on agriculture. The irrigation is effected by damming the streams and throwing the water into larger and smaller ditches (*acéquias*) surrounding and intersecting the whole cultivated land. The inhabitants of towns and villages, therefore, locate their lands together, and allot to each one a part of the water at certain periods. These common fields are generally without fences, which are less needed, as the grazing stock is guarded by herdsmen.—pp. 22, 23.

A third, much neglected branch of industry in New Mexico is the *mines*. Many mining places now deserted prove that mining was pursued with greater zeal in the old Spanish times than at present. This may be accounted for in various ways,—by the present want of capital, want of knowledge in mining, but especially the unsettled state of the country and the avarice of its arbitrary rulers. The mountainous parts of New Mexico are very rich in gold, copper and iron, and afford some silver. Gold seems to be found to a large extent in all the mountains near Santa Fe, south of it to a distance of about one hundred miles, as far as Gran Quivira, and north for about one hundred and twenty miles up to the river Sangre de Cristo. Throughout this whole region gold dust has been abundantly found by the poorer classes of Mexicans, who occupy themselves with the washing of this metal out of the mountain streams. At present the old and the new *Placer*, near Santa Fe, have attracted most attention, and not only gold washings, but some gold mines too, are worked there. As far as my knowledge extends, they are the only gold mines worked now in New Mexico. But as I have made an excursion from Santa Fe for the special purpose of examining these mines, I must refer the reader, in relation to them, to that chapter of my narrative. As to the annual amount of gold produced in New Mexico, I am unable to give even an estimate. Since nearly all the gold of the country is bought up by the traders, and smuggled out of the country to the United States, I believe that a closer calculation of the gold produced in New Mexico could be made in the different mints of the United States than in Mexico itself. In Spanish times, several rich silver mines were worked at Avo, at Cerrillos, and in the Nambe mountains, but none at present. Copper is found in abundance throughout the country, but principally at Las Tijeras, Jemas, Abiquiu, Guadelupita de Mora, etc. I have heard of but one copper mine worked at present south of the Placers. Iron, though also abundantly found, is entirely overlooked. Coal has been discovered in different localities, as in the Raton mountains, near the village of Jemez, southwest of Santa Fe, in a place south of the Placers, etc. Gypsum, both common and selenite, are found in large quantities in Mexico; extensive layers of it, I understood, exist in the mountains near Algodones, on the Rio del Norte, and in the neighborhood of the celebrated "Salinas." It is used as common lime for whitewashing, and the crystalline or selenite instead of window-glass. About four days travelling (probably one hundred miles) south-southeast of Santa Fe, on the high table-land

between the Rio del Norte and Pecos, are some extensive *salt lakes*, or "*salinas*," from which all the salt (muriate of soda) used in New Mexico is procured. Large caravans go there every year from Santa Fe in the dry season, and return with as much as they can transport. They exchange, generally, one bushel of salt for one of Indian corn, or sell it for one and even two dollars a bushel.—pp. 24, 25.

Of the state of Chihuahua he observes:—

Its many and rich silver mines have been celebrated for several centuries. They are found principally in the western part of the state, throughout the length of the Sierra Madre, and in a mean breadth of thirty leagues. The silver ores occur generally as sulphurets, with iron or lead, sometimes as native silver and muriate of silver, and are found either entirely in porphyritic rocks, or in stratified rocks, (limestone,) passing at greater depth into igneous rocks. They are worked either by amalgamation, or by fire in common furnaces. For the latter process they need generally an addition of greta, (litharge, or oxyd of lead,) which forms, therefore, a valuable article of trade. Besides the silver mines, rich mines also of copper, and some of gold, lead, iron, and tin, are found. The most noted mines of the state, of older and more recent date, are the following:

The mines of *Santa Eulalia*, near Chihuahua, have during the last century produced immense masses of silver, as the following fact may prove. The cathedral in Chihuahua, a most splendid building, was within the last century erected from a fund created from the proceeds of the Santa Eulalia mines, by a grant of one real (12½ cents) on every marc of silver (worth $8 25) obtained from the mines. This fund was created in 1717, and in 1789 the cathedral was finished, at an expense of $800,000. The amount of silver taken in these seventy-two years from the mines would, therefore, be $52,800,000. The abundance of lead found in Santa Eulalia, makes the smelting of the silver ore very convenient. The mines are not yet exhausted; but from intrusion of water, want of capital, and the attraction of new mines, they are but little worked.

The mines of *Parral* (Hidalgo) are the oldest of the state, and have also been extremely productive in silver; but for want of regular mining, most of them, though not exhausted, are made inaccessible and worthless.

The mines of *Santa Barbara*, discovered in 1547, were renowned for both silver and gold ores, but are now entirely abandoned.

The mines of *Batopilas* were celebrated for the large masses of native silver, and the unusual richness of the ore.

South of Batopilas lies the rich mine of *Morelos*, discovered in 1826, where one mass of native silver was found weighing two hundred and thirty marcs.

The mine of *Sierra Rica*, west of the old Presidio de San Carlos, was begun to be worked by a company in 1829. The prospects at first were most flattering: the superficial layers of the silver ore produced from one to a hundred marcs in the carga, sometimes one hundred and fifty, and in one instance even three hundred and twenty-seven marcs;

but at the depth of eighty varas the mine seemed to give out, and the invasions of hostile Indians became at the same time so troublesome, that the mine was abandoned.

Such extreme richness of ore is of course not a common occurrence; and the result, found by comparison of Mexican and European mines, that the mines in Mexico are generally poorer as to the relative amount of silver, but far superior as to abundance and extent of the ore, seems also to correspond with the mines in the state of Chihuahua; because a silver mine furnishing from three to four ounces of silver in the carga, is generally considered good enough to be worked with advantage; and many with less per cent. are rendered profitable.

In recent times, the mines of *Guazapares* and of *Jesus Maria* have attracted most of the capital of the state. The latter, southwest from Chihuahua, on the height of the Sierra Madre, were discovered in 1821; and so many valuable silver mines, beside some gold mines, have since that time been opened, that it promises to be for a long time one of the richest mining districts in the state.

Of the copper mines in the state of Chihuahua, the most celebrated is the "*Santa Rita de Cobre*," in the western angle of the Sierra de Mogoyon, near the headwaters of the Gila. The mine, known for a long time to the Apaches, passed through the hands of several proprietors, till in 1828 it was effectually worked by Mr. Coursier, a French resident in Chihuahua, who is reported and generally believed to have cleared from it in seven years about half a million of dollars. The ore looks extremely rich; it is a remarkably pure oxyd of copper, accompanied sometimes with the native metal, and said to contain some gold. Mr. Coursier soon monopolized the whole copper trade in Chihuahua; and as the state at that time coined a great deal of this metal, he made a very profitable business of it; but at last the mine, which seems to be inexhaustible, had to be abandoned on account of hostile Indians, who killed some of the workmen, and attacked the trains. These copper mines are claimed by the state of Chihuahua, as belonging to its territory; but as not even the latitude of the city of Chihuahua had been well determined by the Mexicans, more exact astronomical observations may perhaps prove that they fall within the territory of New Mexico. This question may become of importance, because this whole range of mountains is intersected with veins of copper and placers of gold. Cinnabar also, says rumor, was discovered there in 1824, but nothing positive is known in relation to it.

Coal has been found at present only in two places in the state, near the mines of Carmen and near those of Sierra Rica; but it will probably occur in other localities.

After this short review of the mines in the state of Chihuahua, the question of course will arise, What is *the annual production of these mines?* The only data to which I can refer, are the following: In the twenty-four years from 1738 to 1761, the amount of silver produced in the state of Chihuahua was 3,428,278 marcs, or $28,283,293; and in the seventeen years from 1777 to 1793, 1,394,161 marcs, or $12,501,828.

The following is the estimated amount for later years:

In 1824	69,816 marcs, or	575,982 dollars.
1826	138,015 "	1,138,623 "
1827	129,402 "	1,067,566 "
1828	142,785 "	1,177,976 "
1830	128,747 "	1,062,163 "
1831	138,916 "	1,146,057 "
1832	117,484 "	969,243 "
1833	116,802 "	963,616 "
1834	109,419 "	902,707 "

More recent dates I was unable to get, though I understood from competent persons that the amount of silver had in the last twelve years considerably increased. The computator of the above tables estimates that the annual average amount of the production of silver and gold in the state of Chihuahua is 125,000 marcs, or $1,031,251; but he supposes that but 100,000 marcs of that sum pass through the mint, and that 25,000 marcs are every year smuggled out of the country.

There is a well managed mint (casa de moneda) in Chihuahua, coining gold, silver, and copper. Mr. J. Potts and brother are the present proprietors, in consequence of a contract made with the government of Chihuahua. As all the silver ore in the state contains more or less gold, they separate it before coining, in large platina vessels, with sulphuric acid. For coining a marc of silver without separating the gold, they receive two reals, (25 cents;) for coining and separating the gold, five reals; but the marc of silver from which the gold is to be separated must contain at least sixteen grains of gold.—pp. 56, 57, 58.

This valuable document contains also a Botanical Report of much interest, in the preparation of which Dr. Wislizenus was assisted by Dr. G. Englemann of St. Louis.

Brevet Major W. H. Emory, on his way to Santa Fe, left Fort Leavenworth, on the Missouri River (39° 21′ N.), and went by Council Grove to the Arkansas and thence along this river to Bent's Fort (38° 3′ N., 103° 1′ W.); thence southwest, crossing the Purgatory near its head, the Raton pass at a height of 7500 feet above the sea, to Vegas, San Miguel and Santa Fe. From here the Expedition followed down the Rio del Norte to latitude 33°, and thence turned westward, taking the head waters of the Rio Gila, following it to the Colorado which it meets in longitude 114° 37′; thence still westward, crossing a sandy desert ninety miles in breadth, to the Cordilleras of California, and surmounting these heights, to San Diego (lat. 32° 45′ N.) and other places on the Pacific coast.

The company belonged to the first dragoons under the command of Col. Kearney. They started from Fort Leavenworth on the 27th of June, 1846.

Between Fort Leavenworth and Pawnee Fork, the rolling prairies are traversed by many streams, the beds of which lie deep with almost vertical banks, "developing where the streams

make their incisions in the earth, strata of fossiliferous limestone, filled with remains of crinoidea."

About thirty miles from Fort Leavenworth, on a branch of the Wah-karussi, a bed of bituminous coal outcrops, which is worked by the Indians. Approaching the Pawnee Fork, the country changes imperceptibly, and merges into the arid wastes of that section. Cacti and other spinose plants first made their appearance in 98° W., and near the same region the buffalo grass (Sesleria? dactyloides, *Nutt.*) begins.

Bent's Fort is about 3958 feet above the sea, which gives for the Arkansas a fall of $7\frac{4}{5}$ feet per mile between this point and the meridian of 98° W., a distance of 311 miles. The river has grassy flats of half to two miles in width; but "beyond this the ground rises by gentle slopes into a wilderness of sand-hills on the south, and into prairie on the north." A conglomerate of pebbles was observed along the river in this part, and higher up an argillaceous limestone containing ammonites, &c. "The soil of the plains is a granitic sand, intermixed with the exuviæ of animals and vegetable matter, supporting a scanty vegetation. The eye wanders in vain over these immense wastes in search of trees. The principal growth is the buffalo grass, Cacti in endless variety, Yucca angustifolia (soap plant), Darlingtonia brachyloba, Schrankia uncinata, Cucurbita aurantia (prairie gourd), and very rarely that wonderful plant, the Ipomea leptophylla, called by the hunter, man-root, from the similarity of the root in size and shape to the body of a man. It is esculent, and serves to sustain human life in some of the many vicissitudes of hunger and privation to which men who roam the prairies are subjected." The only tree of any magnitude along the Arkansas, is the cottonwood (Populus canadensis).

From Bent's Fort south, they met with beds of limestone, sandstone, basalt and a porous volcanic rock. On the Moro, in latitude 35° 54′, "the plains were strewed with fragments of brick-dust colored lava and scoria, and the hills to the left were capped with white granular quartz."

On either side of the narrow valley of the Santa Fe—which varies from 1000 feet to a mile or two in width—"the country presents nothing but barren hills, utterly incapable, both from soil and climate, of producing anything useful. The valley is entirely cultivated by irrigation." "Five miles below the town, the stream disappears in the granitic sands" (p. 34). The height of Santa Fé above the sea, according to the barometric observations taken, is 6846 feet; the neighboring peaks to the north are many thousand feet higher. The valley of the Del Norte to the south as far as Angosturas, was narrow with no interval for agriculture. Below the last mentioned place, the valley opens into a plain which is cultivated by irrigation. Farther south the river valley affords little land for cultivation, and the country either

side is as dry as before described. The sandy plains terminate in steep hills, in some places capped with basalt (34½° N).

On leaving the Del Norte, for the west, they mounted the table land, "some 200 feet above the valley, and found the country very level, except where indented by water-courses. The table land stretched off far to the south." Pebbles of chalcedony were common in the plains and in the dry valleys. Near the headwaters of the Mimbres, near 108° W., there was a dome-shaped mountain, and amygdaloidal rocks and volcanic glass were observed. There were also some deserted copper mines in the region, from which specimens of native copper, sulphuret of copper, and a silver ore, were obtained. Twenty miles beyond they found a blue limestone, and magnetic iron ore. The Gila, a rapid river, was soon after reached. Granite, sandstone and volcanic rocks were observed along its course. Near longitude 111° W., ores of copper and iron were met with. About the mouth of the Gila, where it enters the Colorado, the mountains were of grayish granite, traversed by seams of white quartz; they rose abruptly from the plains.

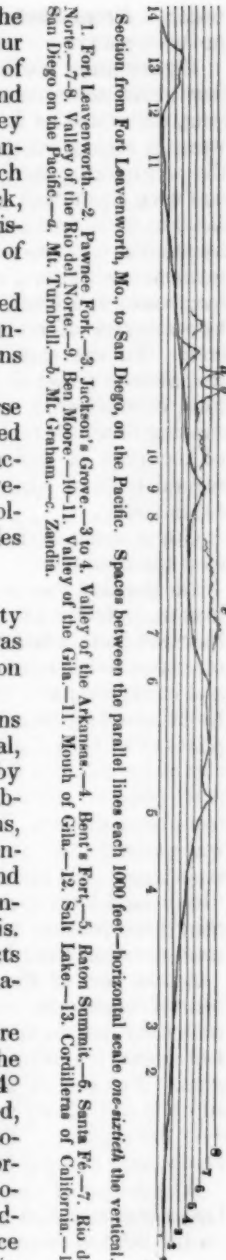
Reviewing the region passed over since leaving the Arkansas, a distance of about 1200 miles, the author observes, that there is a general uniformity of physical character and climate. "In no part of this vast tract can the rains be relied on, to any extent, for the cultivation of the soil. The earth is destitute of trees, and in great part also, of any vegetation whatever. A few feeble streams flow from the mountains, which in many places traverse this region. Between these streams the plains and mountains are without water and vegetation, and may be called deserts, so far as they perform any useful part in the sustenance of animal life. Cultivation is therefore confined to the narrow strips of land within the level of the waters of the stream; and wherever practiced in a community with any success, or to any extent, it involves a degree of subordination and absolute obedience to a chief, repugnant to the habits of our people. The chief who directs the time and the quantity of the precious irrigating water, must be implicitly obeyed by the whole community." (p. 98). "No one who has ever visited this country, and who is acquainted with the character and value of slave labor in the United States, would ever think of bringing his own slaves here with any view to profit, much less would he purchase slaves for such a purpose. Their labor here, if they could be retained as slaves, among peons nearly of their own color, would never repay the cost of transportation, much less the additional purchase money." —(p. 99.)

After fording the Colorado, the party entered a dreary desert, and for 90 miles found no freshwater, except a little from pools; the surface was loose sand, with only two patches of grass. A salt lake was passed, about half a mile in length. On leaving

the desert region and entering a valley in the mountains, they came upon a large sulphur spring, around which were efflorescences of sulphate of lime, sulphate of magnesia and common salt. Ascending the mountains, they were led to a hot spring near Warner's rancheria, having a temperature of 137° F., which discharged from the fissure of a granite rock, a large volume of water; and for a long distance down, it charged the air with fumes of sulphuretted hydrogen.

The accompanying cut is a much reduced copy of a sectional view of the Rocky mountains, made from the barometrical observations of the party.

Many new plants were collected in the course of this expedition, which are partly described in an appendix by Prof. Torrey, with an account of the ferns by Dr. Engelmann. Several lithographic plates are inserted in the volume, illustrating the regions visited, besides upwards of thirty species of plants.



Section from Fort Leavenworth, Mo., to San Diego, on the Pacific. Spaces between the parallel lines each 1000 feet—horizontal scale *one-sixtieth* the vertical.

1. Fort Leavenworth.—2. Pawnee Fork.—3. Jackson's Grove.—3 to 4. Valley of the Arkansas.—4. Bent's Fort.—5. Raton Summit.—6. Santa Fé.—7. Rio del Norte.—7–8. Valley of the Rio del Norte.—9. Ben Moore.—10–11. Valley of the Gila.—11. Mouth of Gila.—12. Salt Lake.—13. Cordilleras of California.—14. San Diego on the Pacific.—a. Mt. Turnbull.—b. Mt. Graham.—c. Zandia.

Lieutenant Abert was attached to the party under Lieutenant Colonel Emory, and was principally employed in exploring the region of New Mexico.

This report, like the preceding, contains much scientific information, both geological, botanical, and also zoological, illustrated by plates of fossils, etc. There is besides a vocabulary of the language of the Cheyenne Indians, who live near Bent's Fort. The author mentions the loss of many valuable papers, and among them a grammar of the Cheyenne language, while on his winter's return to St. Louis.

We cite from the report some of the facts bearing on geology, referring to it for information on its many other topics.

At Bent's Fort specimens of selenite were brought in, besides quartz crystals. Near the Raton Pass, in latitude 37° 15′, longitude 104° 35′, a bed of bituminous coal was discovered, in a high bluff bank. The fossil leaves associated were dicotyledonous, (one a large cordate leaf like Catalpa, and the other lanceolate), which indicates the comparatively modern age of the deposit. Not far from this place a dike of cellular rock was seen, six feet in

width. From Santa Fe, Lieutenant Abert visited the gold mines in the vicinity.

Eighty miles north of Santa Fe, in the Puebla de Taos, are a few small settlements, situated in a valley eight or nine miles long, cultivated as far as practicable by irrigation; the supply of water is scanty except during the wet season. Snow is seen on the neighboring heights in every month of the year; yet wheat and corn ripen well in the plains. Southwest of Taos, a ridge 2000 to 2500 feet high, of hard slaty rock, breaking into angular fragments, was passed. On the west bank of the Del Norte, 40 miles above Santa Fe, the table land reaches to the river, and terminates in a bluff 300 to 400 feet in height. The section exhibits layers of horizontal sandstone capped by dark vesicular lava. To the east, the country rolls away to the base of the mountains, presenting little else than a succession of gravelly hills, covered with dwarf cedars. The lava alluded to forms the capping of all the table lands in Upper New Mexico. To the west of the river in this part, at a place called Ojo Caliente, there are several mineral springs, from which sulphuretted hydrogen escapes freely.

Going south from Santa Fe, volcanic rock was often met with over the country.

On the Rio Puerco, a few miles west of the del Norte, at Poblazon, (lat. 35° 13′,) the sandstone rocks were in some places six hundred feet in height. "The beds had an anticlinal dip, with reference to the axis of the valley." Besides calc spar crystallized and uncrystallized, fragments of large ammonites, hippurites and Inocerami were found, and "the little knobs around glittered with plates of selenite," an abundant mineral in that region. The species of Inoceramus is identical with one figured in Fremont's Report, plate iv. fig. 2. These *cretaceous* fossils occur about 6000 feet above the sea. Farther to the westward, a volcanic country was entered, and in some places a bed of volcanic rock overlay sandstone. To the northward, the village of Acoma is situated "high on a lofty rock of sandstone." "Quantities of fine large clingstone peaches were spread out on the ground, as the owners were dividing their loads."

Again, east of the del Norte, near 34° 50′ N., they met with beds of limestone containing patches of hornstone, and afterward with lofty masses of greenstone. About seventy miles east of the Del Norte, are saline lakes that afford all the salt used in the region. Just east of the river, near latitude 35° 15′, they encamped on a salt plain, where the salt formed a white efflorescence over the surface. The explorations were continued south to Valverde, near latitude 33° 40′.

The return of the party to Bent's Fort, and from there to St. Louis was attended with extreme hardship. They left the Fort on the 20th of January, where the thermometer had stood all day

at 7° F., and were travelling till the 1st of March. As a winter on this route is unknown to our readers, we cite, in closing, a few paragraphs from this part of the Report. Such suffering as is here detailed in a few brief statements of facts, has rarely been exceeded.

February 2.—All night the storm raged with a fury as awful as that of the "tormentes" of Mt. Blanc. The particles of snow beat with wild rage against my tent, while the frail structure quivered, and the poles that supported it creaked and groaned so much that it was impossible for me to sleep. Such was the force of the wind, that it drove the snow through the canvass walls of my tent, and I found my bed and papers covered with it. During the night I heard one of the men, who had got his feet wet in attempting to cross the river, imploring some of his companions to let him get into the wagon with them. The night was terribly cold, and I feared that all of our animals would be frozen to death before morning. At length morning came, but when I looked out the snow was drifting along in dense clouds of hard icy particles, that flew along with extreme velocity. As the sun began to appear the storm ceased, and it was most fortunate for us that it did cease. I now forced my way out of the tent, which was banked with snow. When I looked around, a scene of utter desolation presented itself; most of my men had lain down on the ground to sleep, but now not one of them could be seen. I called aloud; they heard me not, being covered beneath the deep snow. I now went to the wagons; in one I found Pilka and Laing; in the other, two or three men, one of whom had been very ill ever since leaving Bent's Fort. He came rushing towards me half distracted, his shirt covered with snow, his head bare, and crouching at my feet, he implored me to take him to a house. "O, Lieutenant, take me to a house! I shall freeze to death! I'm freezing! I'm freezing!" His arms were drawn up and stiffened, his body almost paralyzed with cold. I took the poor fellow and put him in my own bed, and covered him with blankets and buffalo robes; it was all I could do.

We now searched about and found the men by the aid of the cracks on the surface of the snow, caused by the movements of the restless sleepers; covered by the heavy mantle of snow they had kept extremely warm, and now the chill air felt to them more intolerable.—pp. 115, 116.

February 21.—This morning is the first time for thirty-six hours that any one has ventured out. My men had their provisions ready cooked, and shared them with Mr. Brown's party; of all the tents that had been pitched Friday night, mine was the only one which still remained. The snow had heaped up around the rest so that the inmates were obliged to desert them, and take refuge in the wagons. About mine, the wind had swept in such a way as to keep open a path around it, although the snow was on a level with the ridge pole of the tent. We now broke up some boards that were in the wagons, and kindled a little fire. Soon the sun rose; but, instead of one sun, we had three; all seemed of equal brilliancy, but, as they continued to rise, the middle one only retained its circular form, while the others shot into huge columns of fire, which blended with the air near their summits. The

breadth of the columns was that of the sun's apparent diameter, and their height about twelve times the same diameter; they were between twenty and thirty degrees distant from the sun. Before the sun had risen more than ten degrees, this phenomenon entirely disappeared. Some of the men called my attention to this strange appearance, but so engrossed were they with their own calamities, that they hardly seemed to be in the least astonished at what they saw.

After some little while we missed Preston and the sick man; we inquired, but no one knew anything about them. It was now evident that they had been buried beneath the snow drift, which, for some distance around had filled up the nook in which we had encamped to the level of the prairie; as the drift was of considerable extent, much time would be wasted in examining it, unless we could find where they had pitched their tent. At last I noticed one poor fellow digging away to find his boots; he showed me where the sick man had been. I called the men, and immediately set to work. The snow was six feet deep, and we had only a little piece of board to dig with, and the cold was so great that no one could work very long before his hands became perfectly rigid. After a good deal of hard digging, we found a pair of boots, which were recognized by the men as Preston's property. This urged us to renewed exertions: at length we cleared the snow from a portion of his buffalo robe, and lifting it up, we got sight of the poor fellow's face; he cried out in a weak voice, begging us for God's sake not to leave him to die. We assured him that we would not forsake him, and again covered his face until we could remove more of the snow; having dug as far as his waist, five men caught hold of him to drag him out, but the snow had been moist and was packed very hard, and he was held tight by the tent which had been broken down by the pressure of the snow; however, we dug a little more until we could get at the ridge pole of the tent, which we cut in two with our axes. We now drew Preston out of the drift, which had like to have proved his grave. His bed-fellow, who had been much weakened by sickness, was already dead; he was the man whom we had dragged from Jackson's grove to "Pawnee fork;" where he had been picked up by Mr. Brown; since which time he had been recovering fast. Poor fellow! it was his destiny to leave his bones on the desert prairies, where wolves howl his requiem. I caused the men to dig him also out of the drift, and to put his body into a wagon, in order that we might bury him at the Cotton Wood fork.

Several mules had already been frozen to death. As we proceeded, mules, that had started off in apparently good condition, would drop down in the harness, and their limbs would become perfectly rigid. Even one of the oxen fell down benumbed with cold. In a few hours we lost six mules and one ox, so that our road was marked out with dying animals. As we approached our destined camp ground, we saw a wolf that was so badly frozen as to be unable to move. One of the men put an end to its sufferings by a bullet from his rifle.—pp. 126, 127.

In connection with the above, we refer here to a former Report by Fremont, noticed in vol. iii, pp. 172, 173; also to the account of quicksilver mines in California, in this volume, p. 270.

ART. XXXVII.—*Notice of the Meeting of the American Association for the Promotion of Science, held at Philadelphia, September* 20-25, 1848.

THOSE who had the pleasure of joining in this scientific reunion, will long remember the harmony of the occasion, the ardor of the various members in the prosecution and presentation of their favorite branches—and the real progress which the general high character of the session evinced. The number in attendance was much larger than on any former occasion, when the association met under its old organization, and with its former more restricted plan. And yet many who before have often met on these occasions, were unavoidably detained from the present meeting. The division into two sections—of General Physics, and of Natural History,—proved highly advantageous to the rapid progress of business, and was much approved, although many were thus unavoidably prevented from enjoying the advantages of hearing all that passed in both sections.

The plan of organization, the charter and by-laws, reported by the committee appointed last year for this purpose, were unanimously adopted, and will be the basis of all future operations.

The communications made at the present session were as follows:—

Centripetal force indispensable to whirlwinds. By Professor HARE.

Some notice of the Fossil Cephalopoda, long known by the name of Belemnites, and of the diphosphate of iron, called mullicite, found together at Mullica Hill. By PETER A. BROWNE, Esq.

Report on Meteorites. By Professor C. U. SHEPARD, communicated by Professor B. SILLMAN, Jr.

Report on Winds, or the Laws of Atmospheric circulation in the Northern Hemisphere. By Professor J. H. COFFIN.

Forces in nature, which tend to rupture, contort, depress, and upheave the superficial strata of the earth. By Professor L. G. GERMAIN.

On the Volatility of Potassa and Soda, and their Carbonates. By Professors W. B. and R. E. ROGERS.

On the alleged insolubility of copper, in hydrochloric acid, and on Fuchs's Method of analysis of Iron and Copper Ores. By Professors W. B. and R. E. ROGERS.

Fossil Zoophytes of Western Ohio, with a few additions from other Western localities. By Professor J. W. VAN CLEVE.

On the Sediment of the Mississippi River. By Professor M. W. DICKERSON.

The present tendency of Chemical Philosophy. By T. S. HUNT, Esq.

The Zodiacs of the Asteroids. By Professor J. J. HUBBARD, U. S. N.

On Supposed Indian Antiquities in New York. By Professor O. KELLOGG.

Account of the present state of the Smithsonian Institute. By Professor JOSEPH HENRY.

Fundamental principles of Mathematics. By Professor STEPHEN ALEXANDER.

On the identity of the Atops trilineatus and the Triarthrus Beckii, (Green,) with remarks upon the Elliptocephalus asaphoides. By Professor E. EMMONS.

Report on the Foraminifera dredged in the coast survey. By Professor BAILEY.

Theory of the Geological action of the tides. By Lieutenant C. H. DAVIS. Communicated by Professor PEIRCE.

Observations upon the local distribution of marine animals. By Mr. DESOR. Communicated by Professor PEIRCE.

Discussion of the Flexible Surface. By Professor J. E. OLIVER. Communicated by Professor PEIRCE.

On the principles of analytical mechanics. By Professor PIERCE.

On certain methods of finding the real roots of equations. By Professor PEIRCE.

Theory of the mutual action of two planets, the ratio of whose mean motions is nearly or exactly two to one. By Professor PEIRCE.

On the decomposition of rocks, by meteoric agents. By Professors W. B. and R. E. ROGERS.

On the comparative solubility of carbonate of lime, and carbonate of magnesia. By Professors W. B. and R. E. ROGERS.

On the Fishes of Lake Superior. By Professor AGASSIZ.

On some Improvements in recording Magnetic Telegraphs. By Professor JOHNSON.

Comparison of the Alpine and the Northern Vegetation. By Professor AGASSIZ.

On the Structure of the Phonetic Apparatus of the Crickets. By Professor AGASSIZ.

On the Origin of the Actual Outlines of Lake Superior. By Professor AGASSIZ.

On the Terraces and Ancient River Harbors, the Drift, the Boulders, and the Polished Surfaces around Lake Superior and Lake Huron. By Professor AGASSIZ.

On the Classification of the Animal Kingdom. By Professor AGASSIZ.

A Monograph of the Garpikes. By Professor AGASSIZ.

Critical Remarks upon the Black-banded Cyprinids. By Professor AGASSIZ.

Notices of some new Cyprinodonts. By Professor AGASSIZ.

On the Fossil Cetacea of South Carolina. By Professor AGASSIZ.

Comparison of the Structure of Crinoides, with the Embryonic State of the Star Fishes. By Professor AGASSIZ.

On the Currents of the Ocean. By Lieut. M. F. MAURY.

Mean values of different powers of the radii vectors of an Ellipse. By Professor J. H. COFFIN.

On the absorption of carbonic acid by Liebig's dilute solution of phosphate of soda. By Professors W. B. and R. E. ROGERS.

On the composition of the bittern of some of the salines of Western Pennsylvania. By Professor MARTIN H. BOYÉ, M.D.

On the opposition of Neptune of 1848. By Professor STEPHEN ALEXANDER.

On the Topography of the states of Pennsylvania and Ohio with reference to the construction of railroad communications. By SOLOMON W. ROBERTS, Civil Engineer.

Definitions of Nihility, Space and Matter. By ROBERT HARE, M.D.

On acid springs and the gypsum deposits of the Onondaga salt group. By T. S. HUNT, Esq.

Observations on the physical geography and geology of the North Mississippi. By RICHARD BOLTON. Communicated by Prof. BOOTH.

On a simple mode of alkalimetry and acidimetry. By Professor R. E. ROGERS.

On a new description of self-registering apparatus for meteorological purposes. By Professor J. H. COFFIN.

On the use of Sulphuric acid in certain processes of gaseous analysis. By Professors W. B. and R. E. ROGERS.

On the geological and chemical relations of certain acid and alkaline springs. By Professor W. B. ROGERS.

On calculi found in the whale with results of their chemical analysis. By Dr. KELLER, of Cambridge.

On the two forms of Rhamnus lanceolatus. By T. GREEN.

Antiquities of North America. By M. W. DICKESON.

Comparison of the written and spoken languages of the Chinese. By L. P. ANDREWS, Esq.

Reports on the progress of geographical discovery during the year 1847 and part of 1848. By Professor ALEXANDER, of Baltimore.

Analyses of "Fairmount" or Schuylkill Water. By M. H. BOYÉ and B. SILLIMAN, Jr.

On the dolomization of the recent coral limestone of the Pacific. By Professor B. SILLIMAN, Jr.

The foregoing list is made up without the aid of the returns from the several Secretaries, and may not be quite correct in all respects, although it is believed that it contains all the subjects discussed, relating properly to science.

We are at present able to present only a few authentic abstracts of the several papers, and these are confined to the physical section. We shall, in succeeding numbers and as we can procure the matter from the authors or Secretaries, make such further selections as may be most interesting to our readers. Many of the papers will, no doubt, appear in full from time to time in our pages—as is true of Prof. Shepard's report on meteorites, in our present number.

Abstracts, &c.

On the Alleged Insolubility of Copper in Hydrochloric Acid; with an examination of Fuchs's method for analyzing Iron Ores, Metallic Iron, &c. By Professors R. E. and J. B. ROGERS.

Prof. R. E. ROGERS, in presenting this communication, referred to the opinion received among chemists, that metallic copper is almost

entirely insoluble in pure hydrochloric acid, when oxygen is absent. This which has been made the foundation of an analytical process, first recommended by Fuchs, and since by Fresenius, was proved to be inaccurate. By a particular apparatus, in which carbonic acid gas in one case, and hydrogen gas in another, was made to flow into the space above the liquid and metal, so as effectually to exclude the atmosphere, it was found that continued boiling caused the copper to be dissolved in marked quantity. Even when exposed to the acid at ordinary temperatures, the atmosphere being entirely excluded, it was found that after a prolonged time the metal underwent partial solution, bubbles of hydrogen were evolved, and the dichlorid of copper was formed. The Professors Rogers regard these results as clearly proving the incompetency of Fuchs's method, to afford accurate results.

Professor PEIRCE read a paper upon certain methods of determining the number of real roots of equations applicable to transcendental as well as to algebraic equations. Sturm's theorem is perfect for algebraic equations, but is generally too cumbrous for practical use. By stopping, however, at the first, second, or third, of his functions, whenever either of these is sufficiently simple for direct discussion, the number and nature of the real roots of the given equation can be readily ascertained. Professor Peirce illustrated this method by geometrical diagrams and applied it to some very general cases of algebraic equations.

Mr. SEARS C. WALKER communicated to the Physical section, through Prof. Alexander, the comparison of his ephemeris of Neptune for the opposition of 1848, with the observations received from Hamburg, and Cambridge, England. After applying to the ephemeris a correction published by Mr. W. in the American Journal of Science, the differences between the computed and observed places of Neptune are as follows:

		Obs.—Eph. R. A.	Obs.—Eph. Decl.
Hamburg,	July 10	—0″·06	—0″·83
"	" 11	+2· 51	—0· 68
"	" 12	+0· 78	+1· 86
Cambridge, E.,	" 12	—0· 39	+1· 25
"	" 13	—2· 55	+0· 07
"	" 15	—1· 86	. .
	Mean,	—0· 26	+0· 34

This comparison shows that no correction is needed as yet, either to Mr. Walker's elements of Neptune's orbit, or to the perturbations of the planet as computed by Prof. Peirce.

On the decomposition of rocks, &c., by Meteoric Waters, and on the action of the Mineral Acids upon Feldspar, &c. By Prof. W. B. ROGERS and Prof. R. E. ROGERS.

An abstract of part of this memoir may be found in the last volume of this Journal, page 401.

Experiments were also cited disproving the opinion which appears to be received among chemists, that the feldspars, hornblendes, &c.,

are entirely unacted on by sulphuric or hydrochloric acids. By exposing these materials in fine powder to prolonged digestion in the acid, even at common temperatures, a partial solution was found to result. Thus thirty grains of potash feldspar, by digestion for twelve hours in hydrochloric acid at temperature 60°F., lost nearly one grain, and the liquid furnished chlorid of potassium with chlorid of aluminium.

This communication drew forth some interesting remarks and confirmatory statements from Professors Hare, Henry, W. B. Rogers, R. E. Rogers, Silliman, and Mr. Hunt.

On some Physical Phenomena dependent upon the Progressive Motion of Light. By Prof. Stephen Alexander of Princeton, N. J.

After adverting to the recognized effect of the annual aberration of light, and that which is ordinarily termed planetary aberration, the author more particularly explained the dragging of the shadows of the earth and other planets, first previously noticed by himself in a communication to the American Philosophical Society. Prof. A. then proceeded to the consideration of the case in which light passed through the transparent envelop of a body in motion, and observed that inasmuch as the theory of undulations required that the ether should be possessed of inertia, and the inertia of our atmosphere must be incomparably greater than that of the ether, it would seem to follow, that the velocity of the earth's atmosphere, due to its annual motion, must be impressed upon the light of the sun and stars in the passage of the same through the atmosphere, and thus produce an aberration, which, in so far as the earth's motion was concerned, would be the opposite to that which actually exists, aberration being both in mode and measure, what it ought to be, if the earth had no atmosphere. Prof. A. suggested that the explanation of this was to be found in the enormous porosity of the atmosphere; by far the greater portion of the rays so passing through as to escape the mechanical action of the molecules. When, however, the quantity of atmosphere to be traversed was so great that light must be nearly absorbed, some sensible portion of it might be subject to the influence in question. Prof. A. then referred to the phenomenon of a blue band, seen by himself and others, bordering that edge of the earth's shadow, into which the moon entered, at the time of the last lunar eclipse, but which was less distinct on the side at which the moon emerged; and showed that these phenomena were consistent with the supposition of such an impulse, accompanied by the dragging of the shadow.

Lastly, Prof. A. suggested that these considerations might have a bearing upon the question of a systematic aberration of the double stars; for if the nature of the envelope of a star were such, that its mechanical impulse could be communicated to the light of the star, the theory of emissions, with reference to such a star, would be quasi true, and the aberration admissible.

On the Topography of the States of Pennsylvania and Ohio, with reference to the construction of Railroad communications. By Solomon W. Roberts, Civil Engineer.—The author commenced by saying that the maps which he exhibited, showed the results of numerous and extensive surveys which had recently been made. A railroad is

in use from Philadelphia to Harrisburg, on the Susquehanna, a distance of 107 miles, passing over a rolling and highly cultivated country but not crossing any high ridges. The Pennsylvania railroad, now in course of construction, from Harrisburg to Pittsburg, at the head of the Ohio river, will be 251 miles in length, making the whole distance from Philadelphia to Pittsburg 358 miles. This line crosses the Alleghany Mountain at Sugar Run Gap; and from Harrisburg to the base of the mountain, a distance of 133 miles, the line follows the valley of the Juniata river, and has no grade greater than twenty-one feet per mile. The curvatures are easy and the road adapted to high velocities. The mountain is ascended on the eastern side by $12\frac{3}{10}$ miles of a grade of eighty feet per mile, similar to that on the Western railroad of Massachusetts. The summit of the mountain is then passed by a tunnel 700 yards long, and the line from the summit to Pittsburg is 106 miles long, with a maximum grade of fifty-two feet per mile.

The railroad distance from Pittsburg to Cincinnati will be 330 miles, by the way of Massillon, Wooster, and Columbus. While the distance by the Ohio river is 495 miles, or one half longer than the railroad, and the railroad may be traversed in about one-fourth of the time required by steamboats on the river. The railroad in Ohio for the greater part of its length will traverse the elevated table lands of that state, which are very favorable for railroad construction.

The speaker described the principal topographical features of the states of Pennsylvania and Ohio, and exhibited a profile of the crest line of the Alleghany mountain for a distance of forty-four miles.

In conclusion, he explained that the best and shortest railroad route from Cincinnati to New York and Boston passed through Pennsylvania and Philadelphia; and that the same was true of a road from St. Louis. And also that from Cleveland on Lake Erie to New York, the distance by the railroad through Pittsburg and Philadelphia, will be eighty miles shorter than by the way of Dunkirk and Piermont.

Report on the Winds of the Northern Hemisphere. By Professor J. H. Coffin.—After some remarks upon the importance in investigations of that kind, of lengthened periods of observation for the purpose of eliminating accidental errors, and of extending the field of research over as wide a field as possible, he proceeded to classify the observations which formed the basis of the report, according to the regions or countries in which they were taken. These were widely scattered over both continents, and the Atlantic, Pacific and Arctic oceans, and embraced an aggregate period of over two thousand years, at five hundred and fifty fixed stations, beside numerous voyages and tours—a more extensive collection, he remarked, than had ever before been brought together for the purpose.

He next pointed out the method he adopted to determine from these observations, the mean course of the wind, which was the same as that by which the traverse of a ship at sea is resolved.

By the aid of extensive diagrams he then proceeded to establish the fact that between lat. $33\frac{1}{2}°$ and lat. 60°, there is a general current from the west, (or rather from a little to the south of west,) extending entirely round the globe, but that as we approach those limits (particularly on

the south) it gradually loses its decided character, and at the limit all trace of a fixed direction disappears, the current at any place being controlled entirely by local influences. This he illustrated by a separate diagram of the winds at Augusta, Georgia. After passing this limit on the south, he showed that a current from the opposite direction sets in, which, as we go south, gradually assumed a more decided character till we come fully within the limits of the trade winds. He alluded, in passing, to a peculiarity in the winds west of the Mississippi, between lat. 30° and lat. 40°, as explaining the tracks of storms in those regions.

North of latitude 60° he showed that there are indications that the strong current that comes down from the north in the polar regions veers toward the west; thus establishing a third system, which breaks up about at latitude 60°. The observations taken at various places in Russia and British America, Norway and St. Petersburg in Russia, were alluded to as indicating this fact.

After having gone through with his remarks upon the general course of the winds, he took up the subject of the annual curve which they describe, and showed that while on the eastern coast of Asia it is the same as here, in Europe the curvature seems to be in the opposite direction—also that a curvature physically similar exists in both the easterly and westerly systems of winds.

He next spoke of the relative force of the different winds, showing how far the general results are modified from this cause.

After remarking that he was compelled for want of time to omit several matters embraced in the report, he closed with an expression of thanks to the numerous friends who had aided him in obtaining the necessary data, and whom he mentioned by name, with the kind of aid received from each.

Lt. M. F. Maury, U.S.N., *on the Winds and Currents of the Ocean.*—Lt. Maury reminded the Association that in 1844, they appointed a committee to represent to the Secretary of the Navy, the importance of the services which our armed cruisers might render to the cause of science, by a systematic series of observations upon the currents, temperature and other phenomena of the sea. Judge Mason was a man of enlarged mind and liberal views; he received the representations of the committee as a friend of science and a statesman should do.

It was owing to the impulse thus given, that Lt. Maury had been enabled to carry out a plan which he had long entertained, of constructing a series of charts which should give to each navigator the benefit of the combined experience of all who had gone before him, as to the winds and currents in every part of the ocean. Charts upon this plan, of the North Atlantic, were exhibited before the Association.

They are so constructed as to shew at a glance the prevailing winds, currents, temperatures, &c. for every month in all parts of the ocean. The characters or symbols for the winds are so contrived, that they shew at once both the direction and strength of the wind.

To obtain the results exhibited before the Association, involved immense labor: many thousand old log-books had been overhauled, and the records of each as to winds, temperature of the sea, variation of

the compass, and force and set of currents, compared with all the rest: but the results were of high interest and great value. They shew that the trade winds in the North Atlantic blow with much more regularity on the American, than on the African side of the Atlantic, owing to the fact that in the latter case the sands and deserts which heat and rarefy the air, are to windward; while in the former, they are to leeward. It was also shewn that the trade winds prevail more from the northward on the American, than they do on the African side; and that calms are much less frequent on this, than on that side of the ocean.

By an ingenious manner of discussing the records with regard to winds, Lt. Maury has been led to the discovery of a region near the equator, and extending midway the Atlantic from the shores of Africa, in which, instead of a northeast trade-wind, as there is between the same parallels in other parts of the ocean, there are regular southeast and southwest monsoons.

He pointed out the usual route of vessels bound across the equator from the United States, and shewed that it is over towards the coast of Africa, near the Canary and Cape de Verde islands. It lies through this anomalous region, which it is difficult to cross under sail, owing to the fact that the winds there are mostly head winds. This circumstance led Lt. Maury to the discovery of a shorter route to the Equator through a region of better winds. He had made known this new route to navigators. He had received the returns of seven who had tried it; and the average length of their voyage to the equator was ELEVEN days less than the average by the usual route.

The manner in which his charts were cut up by the tracks of vessels, enabled him to speak confidently as to the existence of a number of *vigias* and other dangers of doubtful position, which disfigure our best and most accurate general charts. Many of these, he pronounced to have no real existence. He is preparing a list of such as may be erased from the charts of the North Atlantic.

Many curious and interesting facts were exhibited concerning the temperature of the ocean. Among these, Lt. Maury pointed out, off the shores of South America, between the parallels of 35° and 40° S., a region of storms, and of ocean temperature as high as that of our own Gulf Stream, whereas in the middle of the ocean and between the same parallels, the temperature of the water was not so great by 22°, and storms by no means so frequent.

Lt. Maury lamented the neglect of the thermometer—a most useful little instrument—among navigators generally. New York, he said, owed her commercial supremacy in a great degree to the water-thermometer. Up to the time when Dr. Franklin with this instrument discovered the Gulf Stream, Charleston had more foreign trade than New York and all the New England states together. Charleston then was the half-way house between them and Europe. When a vessel, attempting to enter the Delaware or Sandy Hook, met a northwest gale or snow storm, instead of running off a few hours into the Gulf Stream, to thaw and get refreshed by the genial warmth of its waters, as she now does, she put off for Charleston or the West Indies, and there remained till the return of spring before making another attempt.

New York now has more direct trade in a week than Charleston has in a year. Perhaps Dr. Franklin with his water-thermometer, and Jeremiah Thompson & Co. with their packet-ships, may be regarded as the two most powerful agents of the many concerned in this revolution.

The frequent and general use of the water-thermometer by navigators, is the only means by which we can arrive at a proper knowledge of the aqueous circulation of the globe, of the currents and isothermal lines of the ocean.

The Secretary of the Navy has authorized copies of these charts to be given to every navigator who would return to the National Observatory, according to form, an abstract of his voyage. Several thousand sheets of the chart have already been distributed upon these terms, and there are now engaged upon all parts of the ocean, hundreds of vessels making and recording observations for this work. Never before was such a corps of observers known. The commercial marine of no country can boast of more accomplished navigators than those of the United States.

The importance of simultaneous observations in all parts of the ocean, was dwelt upon with much earnestness. The field is as wide as the ocean, and there is room in it yet for multitudes of laborers. The work is not exclusively for the benefit of any one nation or age, and it was suggested whether the states of Christendom might not be induced to coöperate by their navies in the undertaking.

The next annual meeting of this Association, stands adjourned to Cambridge, Mass., on the 2d Tuesday (14th) of August, 1849. President, Joseph Henry; Secretary, Dr. Jeffries Wyman. The auspicious character of the Philadelphia meeting—the great interest it has excited in the minds of those who were present—the advantages offered by Cambridge to draw together men of science—all contribute to support the opinion that much may be expected of the session of 1849. In the matter of publication, the Association have ordered the Secretaries of the Sections, and the general Secretary, to prepare a full report of all the papers read before their several meetings, and to submit them to a Publishing Committee, who are charged with the issue of a volume of proceedings. No abstracts of papers read, or remarks made before the sections, will be published, unless the same have been furnished or approved by the authors. It is hoped that another year may enable the Association to publish a volume with full memoirs and reports, as well as abstracts. For this purpose, a much more general enrollment of members will be necessary.

The present session of the Association lasted five days, during which time, three daily sessions were held, in the halls of the University of Pennsylvania on Ninth street.

Art. XXXVIII.—*Report on Meteorites;* by Charles Upham Shepard, M.D.

[Read before the American Association for the Promotion of Science, at Philadelphia, Sept. 20, 1848.]

Having completed the description of the meteoric iron-masses of the United States, it now remains to describe the American meteoric stones. As a result of new observations respecting these bodies generally, it becomes necessary to propose a slight modification of the classification previously adopted.

Class II. *Stony.*

Order 1st, Trachytic.	Section 1.	Fine grained.	Iowa. Tennessee.
	Section 2.	Coarse grained.	Weston, Conn. Richmond, Va.
Order 2d, Chladnitic.	Bishopsville, S. C.		
Order 3d, Carbonaceous.	Cold Bokkeweld, South Africa.		
Order 4th, Trappean.	Chantonnay. Renazzo.		

Appendix.

Pumice-like.

a. Waterville, Me.
b. Concord, N. H.

The localities to be described under the above classification, with the dates of fall, &c., are as follows:

Class II.

Order 1st. Section 1st. *Fine grained.*

1. Linn Co., Iowa. Fell Feb. 25th, 1847, 2h. 50m. P.M. Described by Shepard. Weight about 75 lbs.

2. Castine, Maine. Fell May 20, 1848. Described by Shepard. Weight 1½ oz.

3. Nanjemoy, Maryland. Fell Feb. 10, 1825. Described by Carver and Chilton. Weight about 16 lbs.

4. Sumner Co., Tennessee. Fell May 9, 1827. Described by Seybert. Weight 11 lbs.

5. Forsyth, Georgia. Fell May 8, 1829. Described by Silliman, Sen., and Shepard. Weight about 36 lbs.

6. Nobleboro, Maine. Fell Aug. 7, 1823. Described by Cleaveland and Webster. Weight about 5 lbs.

7. Little Piney, Missouri. Fell Feb. 13, 1839. Described by HERRICK and SHEPARD. Weight about 50 lbs.

Section 2d. *Coarse grained.*

8. Weston, Connecticut. Fell Dec. 14, 1807. Described by SILLIMAN, Sen., and KINGSLEY. Weight about 300 lbs.

9. Richmond, Virginia. Fell June 4, 1828. Described by SHEPARD. Weight 4 lbs.

Order 2d.

10. Bishopsville, South Carolina. Fell March, 1843. Described by SHEPARD. Weight 13 lbs.

APPENDIX.

a. Waterville, Maine. Fell March, 1843. Described by SHEPARD. Weight about 3 oz.

b. Concord, New Hampshire. Fell Oct., 1846. Described by SILLIMAN, Jr. Weight 370½ grs.

Before treating of these different localities, it must be observed, that the ingredient of meteoric stones called olivinite in the preceding report, will hereafter be spoken of as *olivinoid;* since reasons of sufficient weight have presented themselves, in the examination of the substance in question, to authorize its separation from the common volcanic mineral (as well as from the transparent crystals and grains contained in the Siberian and the Atacama meteoric irons). The olivinoid has a hardness equal only to 5·5....6; while olivine is from 6·5....7. The former turns black, and fuses easily before the blowpipe; while the latter grows pale and is infusible. Olivinoid is more easily attacked by the acids than olivine: moreover, it seems most probable, from what is at present known of its composition, that the olivinoid is throughout, a bisilicate, and not a simple silicate.

I have distinguished another equally abundant earthy mineral in meteoric stones as new, under the name of *howardite*, which was detected in consequence of its existing in an almost perfectly insulated state in the Iowa stone. This will be described under the account now to be given of that meteorite.

1. *Linn Co., Iowa.*

I have given the principal facts attending the fall of stones at this locality, in the Amer. Journ. of Science, ii ser., Vol. iv, p. 288. It is only requisite to add, that the small stone seen to fall, was picked up on the land of Mr. Daniel C. Rogers, situated on section 21, township 82 north, range 6 west. The larger portion of the fallen meteor was found in section 20, from a mile to a mile and a half, west. This consisted of two masses and not as first supposed, of the fragments of a single

stone. The larger of the two (whose weight was estimated at above 40 lbs.) was cracked through the centre, by its fall upon the frozen ground. One of these halves (weighing 21 lbs. 7 oz.) is in my possession. The smaller perfect stone is represented, by the finder of it, to have been pyramidal in its shape; and to have measured not far from 10 inches in length, by 8 at its base, and 4 at the smaller extremity. It was completely coated by a black crust, like the other two stones. This stone (as well as one-half of the larger mass) has been broken up, and for the most part entirely lost. The few fragments of it in my possession, sufficiently evince that it differs in no sensible manner from the other two, which are now to be more particularly described.

The smaller stone will be best described, by comparing it to a short rectangular prism (the longer side measuring 4 inches, the shorter, 2½ inches) surmounted at one extremity by a four-sided pyramid of unequal and much curved faces, and terminated at the opposite end by an oblique, waving plane, upon which the stone is most conveniently placed for inspection. When in this position, the apex of the pyramid is 3½ inches from the base. The angles and edges of the mass, as is usual in such bodies, are rounded and blunt. It has but few depressions in its surface. The crust is perfect in its continuity, and is smooth and black, though not shining. The stone weighs 2 lbs. 8⅛ oz.

The large mass (of 21 lbs. 7 oz.) is an irregularly shaped, four-sided pyramid, the summit of which, in place of being a point, is an edge of four or five inches in length. The base of the pyramid is formed by the fractured surface, which is nearly plane, and strikingly resembles the face produced by fracturing a similarly sized block of fine grained granite. The natural outside of the stone presents the customary depressions, though they are less distinct than we sometimes observe in these productions. The crust is similar to that in the small stone already described, only it remains to be noticed, that its thickness is greater than common, (being that of bonnet-pasteboard,) its adhesion to the unaltered stone strong, while its line of junction with the same, is perfectly defined throughout. When narrowly observed, it is discovered that the surface of this crust is divided off, by cracks, into polygonal areas, of from ¼ to ½ an inch in diameter, a consequence no doubt of sudden cooling.

The color of the stone within, is an uniform pearl grey. A closer inspection renders visible specks of iron rust, (though less abundant than common,) and numerous highly brilliant globules of nickeliferous iron. It requires a still nearer search to detect the magnetic pyrites, which is far less abundant than the metallic grains. Blackish veins and glazed joints are nearly obsolete in the Iowa stones. The same may be said of the little ovoid masses, which are also so frequent in most other stones.

The most remarkable feature of the Iowa stone, however, consists in the homogeneousness of its earthy composition. It appears to contain but a single mineral species of this description, and this is one which, though perhaps the most common in other meteoric stones, has until now escaped a separate recognition. I have therefore ventured to bestow upon it a distinct name, that of *howardite*, in honor of an individual whose early scientific labors in this branch of meteorology, rank next in importance to those of Chladni himself.

The proportions of the ingredients in this stone, approach the following:

Howardite,	83·00
Nickel-iron,	10·44
Magnetic pyrites,	5·
Olivinoid and anorthite,	in traces.

A portion of the stone was carefully cleared of the nickel-iron by means of the magnet, which however was inadequate to the separation of the pyrites.

The stone (well cleared of foreign substances) fused easily before the blowpipe into a black, scoriaceous glass, which was attractable by the magnet.

The powdered stone (cleared of the nickel-iron as above) readily yielded to the action of warm dilute hydrochloric acid; and was quickly brought into solution, with the separation of flocculent silica. Its analysis gave the following result:

Silicic acid,	60·16
Protoxyd iron,	23·50
Magnesia,	11·20
Magnetic pyrites,	4·66
Soda and potassa,	0·30
	99·82
Lime and nickel,	in traces.

Omitting the pyrites, the composition of the mineral may be stated thus:

		Oxygen.	Ratio of oxygen.
Silicic acid,	63·06	31·53	3
Protoxyd iron,	24·60	5·46	1
Magnesia,	11·74	4·70	
Soda and potassa,	·31		
	99·71		

It is therefore a tersilicate of protoxyd of iron and magnesia, $\dot{Fe}\,\ddot{Si} + \ddot{Mg}\,\dot{Si}$.

The composition of the nickel-iron approaches very closely to that of iron 86, nickel 14,—a peculiar alloy, which I have reason to regard as very common in meteor-masses.

2. *Castine, Maine.*

For description of this stone, see this Journal, ii ser., vol. vi, p. 251, 1848.

3. *Nanjemoy, Maryland.*

For a description of this stone, see this Journal, Vol. ix, p. 351, and Vol. x, p. 131. Meteoriten von P. Partsch, s. 63, Wien, 1843.

Its crust resembles that of the Iowa stone, without however possessing its uniformity of thickness, or its deep black color. The proportion and mode of dissemination of the nickel-iron and of the pyrites, is very similar in both; but the color of the earthy mineral in the Maryland, is several shades darker, and more inclining to blue. The iron-rust points are less frequent than in the Iowa meteorite. Like the latter, it is principally composed of howardite; although rounded grains of olivinoid, to the amount perhaps of 15 per cent., are distinguishable with the aid of the microscope.

4. *Sumner Co., Tennessee.*

For accounts of this meteorite, see this Journal, vol. xvii, p. 326, and vol. xviii, p. 200. Die Meteoriten, von P. Partsch, s. 47, Wien, 1843.

The crust much resembles that of the Maryland stone, though it is somewhat remarkable in possessing an uniform brownish black color. Within, the stone is of a light grey, more inclining to white than any meteoric stone of the United States, excepting that of Bishopsville. It abounds in pale yellow grains, which are probably olivinoid. In addition also to the howardite, it contains anorthite in small quantity. The nickel-iron and magnetic pyrites are very minutely diffused; while here and there, little specks of chrome iron may be detected.

5. *Forsyth, Georgia.*

For a brief notice of this stone, see this Journal, Vol. xviii, p. 388; and Die Meteoriten von P. Partsch, s. 57, Wien, 1847.

Having been supplied, through the kindness of President Church, and Prof. Jackson, of the University of Athens, with a specimen weighing half a pound, of this scarce stone, I have been able to subject it to analysis, as well as to determine its specific gravity more accurately than I had been able to do before. It is 3·52.

It contains the following ingredients:

Nickel-iron, ...	10 per cent.
Howardite, ...	70 "
Olivinoid, }	
Anorthite, }	10 to 15 per cent.
Magnetic pyrites, ...	2 to 5 "
Apatite, ...	in traces.

The nickel-iron consists of

Iron, ...	89·00
Nickel, ...	9·60
Chromium and loss, ...	1·40
	100·00

The mixture of the earthy minerals in the stone, gave as follows:

Silicic acid, ...	50·00
Protoxyd iron, ...	33·33
Magnesia, ...	9·30
Lime, ...	5·30
Alumina, ...	1·80
	99·73

6. *Nobleboro, Maine.*

Notices of this stone are contained in Vols. vii, p. 170, and ix, p. 400, also in Boston Journal of Philosophy and the Arts, and Die Meteoriten von P. Partsch, s. 29, Wien, 1843. The crust is a perfectly fused and shining glass, similar to the Juvenas and Stannern stones. The color of the interior is a light ash-grey. When examined by the aid of a lens, it is found to be highly composite in character, although the small fragment in my possession shows neither nickel-iron nor magnetic pyrites. The most abundant ingredient is howardite, through which are disseminated grains of greenish transparent olivinoid, white particles of anorthite, black grains of chantonnite, and a red colored, vitreous, hard mineral, which appears to be either garnet or idocrase.

7. *Little Piney, Missouri.*

Brief accounts of this stone are contained in Vols. xxxvii, p. 385, and xxxix, p. 254.

I have been favored with several additional particulars respecting its fall, from persons who reside in the vicinity of the locality.

It fell near a place known as Pine Bluff, on Gasconade river, in township 37, range 11, W. of the principal meridian, in Pulaski county. Some persons were abroad in the woods at a sugar-camp (a place for making maple-sugar), when their attention was suddenly arrested by a rushing sound, proceeding from a dark colored body, partially enveloped in smoke, which was moving horizontally through the air, at a distance apparently of only 400 feet above the tops of the trees. They compared its size and shape to those of a blacksmith's bellows, moving with the large end foremost. A bright light or blaze was noticed to hover around the blowpipe extremity of the mass, which vibrated up and

down through the space of a few inches. A streak of bright light, 100 yards in length, followed the blaze. Before there was time to utter a word, the meteor had passed behind a neighboring hill, when a loud explosion ensued. At a place about one mile distant, in the direction of the meteor's passage, two men were at work in a field. They heard the explosion, and saw the stone strike the earth, at a distance of two hundred yards from where they were standing. It hit the trunk of a tree, eighteen inches above the ground; and when first discovered, seemed enveloped in smoke. (The foregoing statement was supplied by Mr. T. MacDonald.)

The following letter, dated Sept. 12, 1846, describing the phenomenon, is from Mr. B. B. Harrison, a merchant residing in Little Piney, distant about ten miles from Pine Bluff, where the stone fell. "I recollect the state of the weather on the afternoon of the occurrence. It was perfectly clear and calm. On going out from dinner, I met a man in my door yard who was much alarmed at the sound of distant cannon, as he supposed, proceeding from a northwesterly direction. On the following day I visited a place, twenty miles to the east of this, where the people spoke not only of hearing the same noise, but of seeing a body like a blazing churn pass through the heavens, in a southwesterly direction, the noise, however, proceeding from the northwest. They supposed that something must have fallen from the body within a mile or two of their place. At a place thirty miles farther to the north, the people described the motion of the body as being from the south to the north. I continued travelling about from place to place, for several weeks, in the southwestern part of Missouri, and almost every day heard the same object spoken of, although the statements were very discordant in respect to the direction of the meteor. They generally agreed as to the hour of the day. To the citizens of Potosi (which is eighty miles east of this place), the report appeared to proceed from the south.

"After the lapse of some weeks, I was presented with a fragment of the stone, which led me to visit the place of its fall. It was at the foot of a hill of very gradual slope, about half a mile from the Gasconade river, two miles from Pine Bluff post-office, ten miles from Little Piney post-office, and the same distance from Waynesville. I saw where the stone had struck an oak tree, eighteen inches in diameter. The tree was much mangled, though not broken. I saw small particles of the stone still adhering to the tree, and the wood of the tree in the vicinity of the spot where struck, had the appearance of having been burned by gunpowder. The stone was principally carried away, though I was able to procure many pieces, scattered at a distance from the

tree. That which I supposed to have been the outside of the stone, had a dark brown color, and formed a crust of the thickness of coarse wrapping paper. It had evidently been exposed to intense heat. The injured side of the tree was to the southwest, from which side I was informed that fragments of the stone were projected to a very great distance (three fourths of a mile).

"Those who first visited the place differ greatly as to the weight of the stone, the estimates varying from fifty to one hundred and fifty pounds; my own opinion is, that it must have weighed at least fifty pounds. The place not being far from the public road, the fragments were soon gathered up by travellers, and have been dispersed very widely through the country. It may be proper to add, that I am a native of this place, and that I never saw any other stone resembling the one I send you, here or elsewhere; and that it is quite impossible to account for the injury to the tree, except on the supposition of its being produced by a stone falling from the atmosphere."

The following communication is from M. Frissell, Esq., of Potosi, Mo., dated March 12, 1842:—"The meteor, of which the stone in my possession formed a part, passed in a westerly direction. It must have been large, and I presume that the main body passed on, the piece that fell having formed but a small part of the whole. I did not witness the meteor. Some persons who did, compared it to a trumpet in shape, moving with the expanded end foremost. The time of its passage was between two and three o'clock, P. M. Shortly after it had passed the meridian of this place, it exploded with the noise of a heavy piece of ordnance, at two or three miles distance. I was in my office at the time. My first impression was, that it was an earthquake. I was soon apprised however of what had passed through the air, when I became convinced that the report had proceeded from a meteor. The report was double; like two cannons fired at nearly the same instant, the second being louder than the first. The meteor must have been twenty miles from this place when the explosion took place. I expected that fragments would have been found in this immediate vicinity, but the only one discovered was at Pine Bluff, about eighty miles distant."*

The crust to this stone has about the same thickness as that of the Iowa meteorite, though its line of junction with the mass beneath is less perfectly defined. Its color is rather less black, and its surface less smooth and duller. Judging from one specimen

* Mr. Frissell was so obliging as to present me the specimen here referred to.

in my possession, which exhibits nearly two square inches of natural outside, it would appear that its surface must have been marked by very distinct depressions. The color within also, resembles that of the Iowa stone. The stone consist of

Olivinoid,	40	per cent.
Howardite,	40	"
Meteoric Iron, } Magnetic Pyrites, }	15	"
Anorthite,	5	"

Apatite in traces.

8. *Weston, Connecticut.*

For an account of this stone, see Memoirs of the Connecticut Academy, Vol. i, p. 141; Trans. Amer. Phil. Soc., Vol. vi, p. 323; Medical Repertory, Vol. xi, p. 202; Trans. Amer. Acad., Vol. iii, p. 213; Amer. Journ. Science, Vol. xxxvii, p. 130; Journal de Physique, Vol. lxx, p. 429; Die Meteoriten von P. Partsch, s. 41, Wien, 1843.

Its crust is thicker than in the majority of our meteoric stones, though less perfectly continuous and well formed,—being rough, dull, and filled with crevices. Its color is brownish black. When broken, the interior shows occasional joints, with plumbaginous coatings. The prevailing color within is a dark pearl gray. Scattered through the mass, at frequent intervals, are patches of a lighter color, imparting to it a sub-porphyritic aspect. These lighter portions do not consist of a perfectly homogeneous mineral, but rather of a semi-pulverulent substance, which is probably decomposing howardite. The main ingredient of the meteorite is a purplish gray (sometimes greenish gray) mineral, in rounded grains, which appear to be olivinoid. These again are mixed with other imperfectly formed grains of a lighter colored yellowish mineral (often stained by oxyd of iron). This latter substance is taken for howardite also. Magnetic pyrites (less abundant than in most stones) is irregularly disseminated, in highly tarnished grains.

The nickel-iron is more abundant than in any meteoric stone yet described, presenting itself not only in little points, but in continuous threads and veins and in oval pitted masses, sometimes of more than fifty grs. weight. One of these, in my possession, strikingly resembles in shape some of the lumps of meteoric iron in their natural state.*

* The striking analogy in external figure between meteoric iron-masses generally, and bedded masses of native copper and native gold, (independently of the diminutive cases here referred to,) suggests the idea that the great iron-masses themselves have, at some period, been embraced in an earthy gangue.

9. *Richmond, Virginia.*

For an account of this stone see Vols. xv, p. 196, xvi, 191, and Die Meteoriten von P. Partsch, s. 40, Wien, 1843.

This small and highly interesting stone appears to have been but imperfectly invested by the customary black crust. The natural outside of the fragments which I have examined, possessed the usual smoothness of surface, but were but partially melted. Nor did it appear that any more perfect coating had ever been attached to the surface. Within, the general color is a dark ash gray. Interspersed through the mass, however, are freckles of a whitish mineral, which are probably howardite. The gray portion consists of olivinoid, and forms at least nine-tenths of the earthy portion of the stone.

10. *Bishopsville, South Carolina.*

For my first knowledge of this, the most remarkable of all the hitherto described meteorites of the United States, I am indebted to Dr. J. C. Haynsworth, of Sumterville, South Carolina. His letter to me, (dated April 7, 1846,) which is here given, contains all the information respecting its fall, which I have thus far been able to obtain. "I have in possession a meteoric stone which fell in March, 1843, near Bishopsville, in the northern part of Sumter District. The passage of the meteor and its explosion were witnessed by many spectators, over a region of country of thirty or forty miles in diameter. The descent of the stone itself also, was observed by a number of negroes. Their terror was so great on seeing the excavation it produced, the scattering of the soil, and more than all, by the insupportable sulphurous odors with which the air was filled, that they fled in a panic from the field. On the following morning, however, headed by a white man they returned to the spot; and after digging three feet or more, in a sandy soil, they came upon the stone which I now possess. That it is meteoric is as well known as possible perhaps, in the absence of a scientific analysis. It has more the appearance of limestone than of any other rock with which I am acquainted, though it is much heavier than the same bulk of limerock. It has, moreover, numerous particles resembling oxyd of iron, diffused through it. It is coated with a dark shining surface, resembling glass that has been stained with some metallic oxyd. When first dug up, the sulphurous odor was said to have been overpowering. This has now subsided, though it can be reproduced by friction or slight warmth. It begins to suffer decomposition, from the access of air and moisture to the interior, as portions of the vitreous coating have been removed for specimens, by persons who have examined it."

The stone was purchased for me by Dr. Haynsworth, and is now in my possession. Its weight was thirteen pounds. Its shape may be judged of from the annexed figure 1.

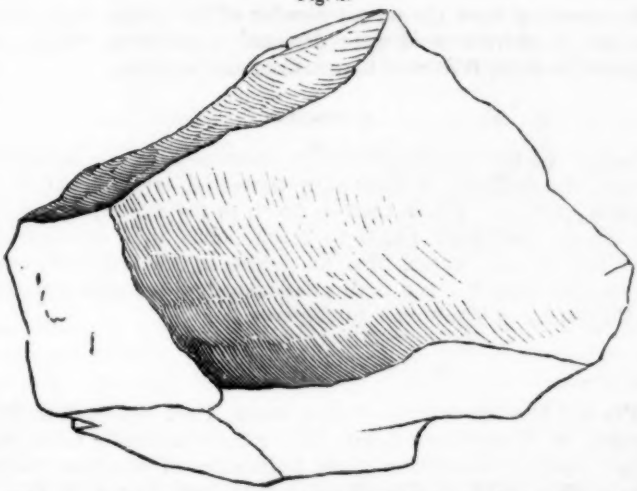
Fig. 1.

It measures 9 inches in its longest diameter, by $5\frac{3}{4}$ and 5, in its transverse dimensions. It is rounded at its thicker extremity, from whence, after bulging somewhat, it gradually tapers to the smaller end, which is obviously pyramidal, with four sides. This is exhibited in fig. 2, where the stone rests on its side.

Being an uncommonly fragile stone, the glazed coating had disappeared from the angles and the ends of the mass, leaving not more than two-thirds of the surface protected by the original crust, which is generally smooth, of a mottled aspect, the colors being black, white, and bluish gray, not unlike certain clouded marbles. The black portions are glossy and obsidian-like, the gray and white for the most part, dull, though the white is sometimes shining and transparent like enamel on porcelain. It is traversed by frequent cracks or fissures, which penetrate for some distance into the stone; the walls of these fissures being themselves partially fused for a little way inward from the exterior.

An interior view of the stone is no less peculiar. The pearly white color of its basis and its feldspathic crystallization, at first view, make it difficult to regard it as any thing else than a decomposing mass of albitic granite. A nearer inspection, however, satisfies the observer, that the white substance (chladnite, which is nearly as tender as laumonite) is different from any terrestrial mineral. It is seen, moreover, to be traversed with little black veins, and here and there to include little grains of deeply rusted nickeliferous iron, some of which are as large as a pea. Black grains and even crystals of sulphuret of chromium (*schreibersite* resembling allanite in form and color) are occasionally visible. Brown colored pyrites, in very minute quantity, is diffused through the stone; and especially is it visible in contact with the sulphuret of chromium. A peculiar blue mineral (iodolite), and a honey-yellow one (apatoid), as well as traces of sulphur, are likewise present in traces in the stone.

Fig. 2.



Whenever the stone is broken or rubbed, it emits the odor of sulphurous acid. Water dissolves from it decided traces of hyposulphite of soda, hyposulphite of magnesia, sulphate of magnesia, chlorid of magnesium, chlorid of sodium, and silicic acid.

The proportions in which the different visible minerals are present may be thus expressed:

Chladnite, ...	90 per cent.
Anorthite,*	6 "

* To this species I refer the globular grains of a gray color. They are less frangible and much harder than the chladnite. In a strong heat, before the blowpipe, it turns white upon the edges, slightly vitrifying, but does not melt. With borax, it slowly disappears, without more than tinging the color of the bead.

Nickel-iron, ...	2 per cent.
Magnetic pyrites, Schreibersite, Sulphur, Iodolite and apatoid, . .	2 "

The above minerals have been described mineralogically in my previous report. It only remains to state the results obtained in the analysis of the chladnite. They are the following:

		Oxygen.	Ratio of oxygen.
Silicic acid,	70·41	35·205	3
Magnesia,	28·25	11·300	1
Soda,	1·39	·338	
	100·00		

It consists, therefore, of $11\frac{1}{3}$ atoms tersilicate of magnesia $+\frac{1}{3}$ of an atom of tersilicate of soda.

In operating upon the mixed powder of the stone, lime, alumina, and phosphoric acid were detected, ingredients which are supposed to have reference to anorthite and apatite.

APPENDIX.

I place the two stones now to be mentioned in an appendix, because the evidence of their extra-terrestrial origin is not, in all respects, perfect. While there is much in the circumstances under which they were found to countenance their genuineness, there still remain several obvious defects in the testimony upon which this depends; nor is this deficiency fully counterbalanced by the nature of the stones themselves.

a. Waterville, Maine.

For my first knowledge of this stone, I am indebted to Prof. Loomis, of Waterville college, Me., who incidentally mentioned to me, (during the meeting of the Association of American Geologists in May, 1845, at New Haven,) that Prof. Keely, of Waterville, had in his possession a portion of a stone that had fallen in that place. The latter gentleman has favored me with a specimen of the stone, and several communications relative to its discovery. He observes that its finder was Capt. Josiah Crosby, of Waterville, that he is a good observer of natural phenomena, has paid considerable attention to mineralogy, and that his character is beyond question. His statement is as follows:

"On a clear, star-light night in Sept., 1826, about midnight, a luminous fireball or meteor came from a southeasterly direction, apparently one-third or half as large as the moon, and proceeded with great velocity, (with a kind of rushing noise like the ap-

proach of a high wind,) in a curved line and with a regular motion towards the earth. The light was intense and the tail or train was of a conical form, like the blaze of a lighted candle. It disappeared from my view, a moment before I heard a report, like that of a small cannon. A few days after, about one-third of a mile distant from the place where I witnessed the appearance described, I found, as I suppose, a fragment of this meteor." Several inquiries were, at my request, proposed to Capt. C., to which he replied in the following note, addressed to Prof. K.: "There has never been a glass-house in this section of the state. The nearest iron works are sixteen miles distant. Common brown earthen ware was manufactured formerly at a place one-third of a mile distant from the spot in a straight line. I have traversed the land a great number of times, bearing the circumstance in mind, yet I have never seen the like substance before or since. It was a solitary stone, the soil consisting entirely of a sandy loam. There was no stone wall, or accumulation of stones within two miles. The specimen, when picked up, appeared to be a newly detached mass. The grass upon which it lay was short and close to the ground, and was entirely unchanged in appearance."

Capt. Crosby presented the mass (whose weight appears not to have exceeded three ounces) to Virgil D. Parris, Esq., formerly a member of Congress, and now United States Marshal at Portland. Mr. Parris gave Prof. Keely the fragment which was presented to me for examination, and subsequently has presented to him the remainder of the mass. Such is the history of this stone.

Its appearance is that of an imperfectly stratified or laminated pumice stone, with double the ordinary compactness of this substance,—the layers being one-sixth of an inch in thickness. It has very little tendency however to separate at these joints; and their existence even is chiefly denoted by a difference of color. The body of the stone is a light ash-grey, while at and near the joints it is iron-black. Indeed the powder of the black matter is attracted by the magnet. The outside of the stone has evidently undergone fusion, subsequently to the interior; and is coated by a thin red-brown crust. It is too vesicular in its texture to allow of a satisfactory determination of its specific gravity.

The stone is composed of the following ingredients:

Silicic acid,	70·00
Protoxyd iron,	8·00
Alumina,	18·50
Magnesia,	2·59
Lime,	1·90
	100·99

b. Concord, New Hampshire.

For a description of this stone see Vol. iv, ii ser., p. 353.

In his account of this body, Prof. Silliman has made an inference in favor of its meteoric character, founded upon the supposed identity of its composition with the Bishopsville stone, or rather with the chladnite, which forms 90 per cent. of this stone. So far as the elements are concerned in the two bodies, the analogy is striking; but the analysis of chladnite, (not then published,) on which I asserted that it was a tersilicate, was based on Dr. Thomson's view of the constitution of silicic acid, whereas Prof. Silliman has adopted the atomic weight of Berzelius. The results of analysis, however, placed side by side, stand thus:

	Concord Stone.	Chladnite.
Silicic acid,	84·973	70·41
Magnesia,	12·076	28·25
Soda,	2·218	1·34
	99·767	100·00

In addition to the analogy of elements found in the composition of these substances, it remains to be stated that there is a manifest resemblance between the melted surface of the Concord stone and certain parts of that of the Bishopsville meteorite, in color, lustre, translucency, and hardness, as well as in behavior before the blowpipe.

The extra-terrestrial origin of meteoric stones and iron-masses, seems likely to be more and more called in question, with the advance of knowledge respecting such substances, and as additions continue to be made to the connected sciences; I may therefore take an early occasion to present the Association with some views, founded in part upon Biot's theory of the aurora borealis, which seem to favor such an origin of meteorites.

The recent study of those frequently occurring and wide spread atmospheric accumulations of meteoric dust, (a single case being recorded where the area must have been thousands of square miles in extent, and where the quantity of earthy matter precipitated must have been from 50 to 100,000 tons in weight,) makes known to us the vast scale on which terrestrial matter is often pervading the regions of the upper atmosphere; and prepares us to appreciate the mode in which the peculiar constituents of meteorites may be translated to those remote distances, where according to the theory of Biot, the clouds of metallic dust are retained.

Great electrical excitation is known to accompany volcanic eruptions, which may reasonably be supposed to occasion some chemical changes in the volcanic ashes ejected; these being wafted by the ascensional force of the eruption into the regions of the magneto-polar influence, may there undergo a species of

magnetic analysis. The most highly magnetic elements, (iron, nickel, cobalt, chromium, &c.,) or compounds in which these predominate, would thereby be separated, and become suspended in the form of metallic dust, forming those columnar clouds so often illuminated in auroral displays, and whose position conforms to the direction of the dipping needle. While certain of the diamagnetic elements, (or combinations of them,) on the other hand, may under the control of the same force be collected into different masses, taking up a position at right angles to the former, (which Faraday has shown to be the fact in respect to such bodies,) and thus produce those more or less regular arches, transverse to the magnetic meridian, that are often recognized in the phenomena of the aurora borealis.

Any great disturbance of the forces maintaining these clouds of meteor-dust, like that produced by a magnetic storm, might lead to the precipitation of portions of the matter thus suspended. If the disturbance was confined to the magnetic dust, iron-masses would fall; if to the diamagnetic dust, a non-ferruginous stone; if it should extend to both classes simultaneously, a blending of the two characters would ensue in the precipitate, and a rain of ordinary meteoric stones would take place.

As favoring this view, we are struck with the rounded, hail-stone-like form of many of the particles of composition (even though consisting of widely different substances) in nearly all stones, and even in many of the iron-masses. Nor are these shapes to be referred to fusion; they evidently depend upon a cause, analogous to that which determines the same configuration in hailstones themselves.

The occasional raining of meteorites might therefore be as much expected, as the ordinary deposition of moisture from the atmosphere. The former would originate in a mechanical elevation of volcanic ashes and in matter swept into the air by tornadoes, the latter from simple evaporation. In the one case, the matter is upheld by magneto-electric force; in the other, by the law of diffusion which regulates the blending of vapors and gases, and by temperature. A precipitation of metallic and earthy matter would happen on any reduction of the magnetic tension; one of rain, hail or snow, on a fall of temperature. The materials of both originate in our earth. In the one instance they are elevated but to a short distance from its surface, while in the other, they appear to penetrate beyond its farthest limits, and possibly to enter the inter-planetary space; in both cases, however, they are destined, through the operation of invariable laws, to return to their original repository.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Nocturnal Radiation, &c.;* by M. Melloni, (Ann. de Chim. et de Phys., Feb., 1848.)—Previous experiments have determined the amount of radiation by thermometers at different distances from the ground, the lower thermometer being surrounded by the radiating substance. The lower strata of air being cooler than those above, reduce the temperature of the lower thermometer—while the naked instrument having itself a high radiating power, does not correctly indicate the temperature of the air in which it is placed.

To avoid these sources of error, the instruments should be placed at the same level, and that intended to measure the temperature of the air should have its radiation reduced to a minimum. As metal foil cannot be applied neatly to the bulbs, the author devised the following mode of experimenting.

A sound bottle cork is pierced with a hole to admit the stem of a thermometer, which is pushed through until the bulb is within $\frac{1}{4}$ of an inch of the cork. It must then be fastened with a little wax and with wedges of wood. The scale which should be marked upon the tube is taken off on a piece of paper and transferred to a *thin* slip of ivory. This is then fastened in a slit in the cork so that it shall coincide with the scale on the tube, and secured in its place. The end of the column of mercury and the corresponding degree on the scale can be easily seen at night, by holding a light behind the strip of ivory.

A little vessel of silver or brass, resembling a thimble, and with a polished surface, is next to be made; it must be large enough to hold the bulb of the thermometer, and to fit tightly on the end of the cork. A similar cap of thin tin plate is to be provided for the scale and tube.

The instrument thus prepared, was proved by experiment to be almost free from the influence of radiation, and consequently a true measure of the temperature of the air—on the other hand a coating of lampblack raised the radiation to a maximum. In the use of these thermometers, they were placed horizontally in tin vessels, having the form of a truncated cone two inches in diameter below, and seven inches above, about four inches deep, and supported on three feet formed by thin tubes of sheet tin two feet long. A hole at the side with a short tube to embrace the cork, allowed the introduction of the thermometer, its bulb being in the centre of the dish, and at little distance from the bottom; plates of tin served as covers.

We have been thus particular in describing these instruments, as they are decidedly the most suitable for this kind of investigation, which have ever been described.

Two thermometers furnished with polished caps, and a third with one coated with lampblack, were exposed in the tin vessels. While *covered*, they stood at the same height, but when the covers were removed from one of the two with polished caps and from the third, the latter (covered with lampblack) immediately fell, and in ten minutes

was 3°·4 Cent. below the other two, which remained stationary. This experiment proved, that the tin vessels completely cut off the radiation, (even of the lampblack,) and that the polished caps had the same effect.

In like manner the radiation of silver was determined by two thermometers capped with that metal—one in a covered, the other in an open vessel, and a third blackened and also in an open vessel. The first showed the temperature of the air, the second the radiation of the silver, and the third that of lampblack. The results of a series of careful observations gave the radiating power of silver 3·026, that of lampblack being 100.—being not far from the recent determination of MM. de la Provostaye and Dessains, by a quite different method.

One important precaution to be observed in all these experiments is suggested by M. Melloni, we believe for the first time. We should not experiment except *at some distance from the ground and in dry weather*—otherwise the instruments soon become bedewed, and the high radiating power of water soon brings them all to the same degree, whatever be the nature of the coating. If the stems are left uncovered, the thermometers are cooled down to the bulb, and the same effect will be noticed.

The radiating power of the following substances was obtained by applying them to the caps of the thermometers.

Lampblack, . . .	100	Isinglass, . . .	96
Carbonate of lead, .	99	Glass, . . .	93
Varnish, . . .	97	Plumbago, . . .	86

The following comparisons were made by placing the substances in a little heap on the bottom of the tin dish, and high enough just to cover the cap of the thermometer.

Lampblack, . . .	100	Sawdust of poplar, .	99
Smooth leaves from various plants, . .	103	" " mahogany,	95
Leaves of elm and poplar,	101	Silicious sand, . .	93
		Mould, . . .	92

The portion of the sky concerned in the radiation is included within 30° or 35° of the zenith. Even clouds beyond this have but little interfering effect.

That radiation takes place not only from the surface but from the parts beneath, was proved by the greater radiation of several coats of varnish than of a single one.

This explains a phenomenon which has been brought as an argument against Wells' theory. It is objected that very thin bodies, such as spider webs, should recover their temperature from the air as fast as they lose it by radiation. Hence such substances should not be covered by the dew. But spider webs are notoriously productive of dew. M. Melloni contends that the webs radiate from all portions of their substance, and therefore lose much more than they can receive, in proportion to other bodies.

A long continued course of experiment has satisfied M. Melloni, that the amount of radiation is usually stated far too high—that while under certain circumstances some bodies can be cooled to 8° Cent. below the temperature of the air four or five feet above—in general the effect of

radiation is to reduce the temperature of vegetation, &c., not more than 2° Cent. below that of the surrounding air. The dampness of the air is such as readily to allow of the deposition of dew with even this small change.

Another important conclusion of our author, is a confirmation of the law just announced by Wilson, that the loss of heat from radiation in a calm, clear night, is uniform at all temperatures of the air.

The whole of this investigation, while it corrects certain inaccuracies and improves the methods of experiment, in every respect confirms the theory of dew, laid down by Wells. G. C. SCHAEFFER.

2. *On the Composition of the Organic Alkalies;* by M. AUG. LAURENT, (Ann. de Chim. et de Phys., May, 1847.)—This distinguished chemist has reëxamined the vegetable alkalies, since much uncertainty prevailed as to their true formulæ, and as for many of them, formulæ have been received, which according to the views of M. Laurent, cannot represent any chemical compound. The error in most cases arises from the fact, that a difference of ·002 to ·003 of hydrogen is sufficient to change their constitution.

By means of a modification of the usual process for organic analysis, he has found that he can determine the hydrogen to ·001. By this process, the following formulæ were established.

We give the notation adopted by the author, as a translation to our system would in some cases involve the use of fractions. It is only needful to remember that H_2 and N_2 of the French authors, are H and N with us.

Quina	$C_{19} H_{22} N_2 O_2$	Narcogenina	$C_{18} H_{19} NO_5$
Cinconia	$C_{19} H_{22} N_2 O$	Opianic acid	$C_{10} H_{10} O_5$
Morphia	$C_{17} H_{19} NO_3$	Opianate of amm.	$C_{10} H_{13} NO_5$
Quinoleina	$C_9 H_7 N$	Hemipinic acid	$C_{10} H_{10} O_6$
Lophia	$C_{23} H_{16} N_2$	Hemipinate of am.	$C_{10} H_{16} N_2 O_6$
Picryle	$C_{21} H_{15} NO_2$	Starch	$C_{12} H_{20} O_{10}$
Narcotina	$C_{23} H_{25} NO_7$	Pyroxyline	$C_{12} H_{17} N_5 O_{27}$
Cotarnina	$C_{12} H_{13} NO_3$	Conina	$C_8 H_{15} N$

G. C. S.

3. *Researches on the Chemical Constitution of Asparagine and Aspartic Acid;* by M. R. PIRIA, (Ann. de Chim. et de Phys., Feb., 1848, trans. from the Italian.)—The chief results of M. Piria's remarkable discoveries in relation to these substances, have already from time to time appeared in various journals; but we now for the first time find the complete memoir, of which we shall give a brief abstract.

Process for obtaining Asparagine.—About 22 pounds of vetches were allowed to germinate in a dark apartment. When the plants were two feet high, they were cut up, the juice expressed and evaporated, after filtration from albumen coagulated by the heat. The almost syrupy liquid deposited an abundant crop of crystals of asparagine. These were purified by two or three re-crystallizations from boiling water, the last time using animal charcoal. The crystals were of uncommon beauty, not unlike those of sugar candy. Copper vessels impart a blue tint, and sulphuretted hydrogen causes this to disappear.

The product of asparagine is 1½ per cent. for the vetches used. The same quantity was obtained from the plants germinated in the light;

but none from the seeds themselves, nor from the plants when the flowers had formed.

The constant acid reaction of the liquid even when concentrated, induced M. Piria to suspect the presence of some foreign acid; but at last he arrived at the conclusion, that the asparagine itself (contrary to all former statements) is really an acid of some power. A saturated solution of asparagine gives when heated with acetate of copper, a rich ultramarine blue precipitate, increasing in quantity on cooling. Its composition is $C_8(H_7\,Cu)N_2\,O_6$—that of asparagine free from water of crystallization, $C_8\,H_8\,N_2\,O_6$. The asparagine may be obtained unaltered from this substance, by the use of HS. A similar compound with potassium has been noticed in this Journal for March, 1847, p. 258.

Action of Ferments.—Under the influence of an azotised principle in the plants, the impure asparagine in solution, or the juice itself, undergoes fermentation, emitting a putrid odor; and there is found remaining a quantity of *succinate of ammonia*, formed by the fixation of $2HO+H_2$.

Asparagine $C_8\,H_8\,N_2\,O_6+2HO+H_2=C_8\,H_{12}\,N_2\,O_8$ succ. amm.

Action of Acids and Alkalies.—It is well known that these agents decompose asparagine into aspartic acid $C_8\,H_7\,NO_8$ and ammonia—2HO being added.

It is incorrectly stated that concentrated hydrochloric acid produces a new and more soluble acid. Our author has found that this is only aspartic acid retained in solution by the hydrochloric acid.

Even nitric acid when pure, forms only aspartic acid; from the solution under certain circumstances, acetate of lead precipitates a double nitrate and aspartate of lead; which however cannot always be obtained.

The reaction of nitric acid containing hyponitric, was quite remarkable; a large quantity of pure nitrogen was given off, when either the asparagine or aspartic acid was used. The complete decomposition was effected by dissolving in nitric acid, and passing a current of binoxyd of nitrogen until no more nitrogen was disengaged; the acid liquid saturated with carbonate of lime gave with acetate of lead, the well known crystalline and fusible *malate of lead*. Analysis confirmed this.

Hence asparagine is an amid analogous to oxamid, and aspartic acid another corresponding to oxamic acid. Their names should be malamid and malamic acid.

M. Piria proved the analogy of this reaction of hyponitric acid upon oxamid, succinamid and butyramid. In all cases nitrogen was given off, and the oxalic or other acid remained in solution. Urea too is transformed, as is well known, into nitrogen and carbonic acid.

The remarkable facility of this decomposition, which takes place even in the cold solutions, is strikingly contrasted with the tedious and never definite decomposition of the amids by heating with caustic potash.

[The distinctness of the reaction of hyponitric acid with the amids, seems to afford us a means of research of vast promise. Most of the azotised compounds of unknown relation, are undoubtedly amids; their decomposition by means of caustic potash is slow, and always affords a variety of products. With hyponitric acid, we shall only have to make allowance for the oxydation by the nitric acid, which would in some instances take place; but this is in general an easy matter for

the oxydation by nitric acid has been well investigated for most of the substances likely to be found.] G. C. S.

4. *On the presence of Copper in the Bodies of Animals;* by M. DESCHAMPS, (Comptes Rendus, Jan., 1848.)—This metal is constantly present in most of the formations in the vicinity of Paris, and seems to be derived from the decomposition of cupriferous sulphuret of iron. It is taken from the soil by plants, and from them by men and animals. Copper and also lead are received in part from cooking utensils, &c. Soils free from copper soon obtain a portion by manures, &c.

Carbonate of ammonia is the means of carrying copper from the soil into plants, and in the azotised compounds of this metal, seems to enter by a replacement similar to that which takes place in certain ammoniacal salts.

These are a few of the conclusions drawn by M. Deschamps from his curious investigations. G. C. S.

5. *On the presence of Arsenic in certain Chalybeate Waters;* by M. AUDOUARD, (Comptes Rendus, Jan., 1848: and by M. FILHOL, Journ. de Pharm. et de Chim., Jan., 1848.)—Both of these authors have proved the existence of arsenic in very minute quantities in chalybeates. The latter found the deposits from springs of the Pyrenees to contain from 0·03 to 0·058 per cent. of arsenic, and sometimes a trace of copper. Both remark that this minute quantity can never give rise to mistakes in case of poisoning.

[Can it have any effect upon the medicinal properties of the waters in which it is found?] G. C. S.

6. *On a new method of analysis of Inorganic matter in Blood: and on the constant presence of several metals in this fluid;* by M. E. MILLON, (Comptes Rendus, Jan., 1848.)—The blood is received in a vessel containing about three volumes of water to one of blood, and introduced into a flask containing chlorine. The organic matter immediately coagulates, changes color and loses all traces of organization. By expressing the clot and washing, the whole inorganic matter is removed and is found in the clear and limpid solution. Not more than one per cent. of organic matter is carried off in solution. The reaction with chlorine is complete in two or three minutes; the separation of the iron in this way is therefore a neat class experiment. The saline ingredients after ignition are examined as usual. Of this residue, 100 parts contain—

Silica,	from	1	to	3	Copper,	from	1·5 to 2·5
Lead,	"	1	"	5	Magnesia,	"	20· " 24· ?

Experiment shows that these metals, like iron, are found only in the globules. This method of analysis is suggested as suitable for all the fluids, &c. of the animal economy. The most repulsive matters furnish immediately a clear saline solution. G. C. S.

7. *New mode of estimating the Sulphur in Organic Substances;* by H. WEIDENBUSCH, (Chem. Gaz., June, 1847, from Lieb. Ann.)—The substance is heated with the strongest nitric acid, and an excess of nitrate of baryta, until all organic matter is destroyed. The mass is dried in a platinum dish at 212°, and then fused, avoiding a deflagration. The fused mass is to be treated with dilute acetic acid, and heated to remove carbonate of baryta. After filtering and washing, a second treatment with acetic acid furnishes the sulphate of baryta perfectly pure. G. C. S.

8. *Preparation of pure Barytic Water and Salts of Baryta;* by H. WACKENRODER, (Chem. Gaz., July, 1847.)—Mix intimately 240 grms. of finely ground sulphate of baryta, with 60 grms. rosin and 20 grms. powdered charcoal. Heat to redness from half to three quarters of an hour. Salts of baryta are prepared by precipitating the solution of the sulphuret, by carbonate of soda.

To obtain the chlorid pure, crude muriatic acid is added to the solution of sulphuret to slight excess; the precipitated sulphur, sulphate of baryta, &c., is filtered off, and the solution evaporated nearly to dryness. The impurities remain in the mother-liquid; adhering chlorid of iron is removed by a faint red heat.

Barytic water is prepared as usual by oxyd of copper. If this metal is found in the liquid after boiling, a small quantity of recently precipitated hydrated oxyd of silver, or its carbonate, will on digestion, remove the copper and hypo-sulphurous acid.

The originality of this process, is in the use of rosin and powdered charcoal instead of meal, and also in a less degree of heat than is usually recommended. About one-third the sulphate is decomposed. The remainder can be used over again. G. C. S.

9. *On the Fusion of Rocks;* by A. DELESSE, (Jour. de Pharm. et de Chem., Jan., 1848.)—The author has observed that the igneous rocks on fusion undergo a diminution in density, when they cool into a vitrified mass, which is the greater in amount as the rocks contain more of silica and alkali, and less when more iron, lime or alumina are present.

As a general rule, the older rocks, as granite, &c., decrease most in density; the order is nearly that of their age down to the most modern volcanic rocks, which undergo but little change. This is of course the reverse of the order of their fusibility.

The author suggests that the crystallization of these rocks has decreased the radius of the earth, as a diminution of volume is the inevitable result of crystallization, whether from fusion or aqueous solution. G. C. S.

10. *On a new Process for covering different Metals with Brass or Bronze*, (Chem. Gaz., May 15, 1848, from Newton's Journal, May, 1848.)—MM. Brunel, Bisson and Gaugain, instead of the cyanids before used, employ a solution in water, composed of 500 parts of carbonate of potash, 20 parts of chlorid of copper, 40 parts of sulphate of zinc, and 250 parts of nitrate of ammonia.

In order to obtain bronze, a salt of tin is substituted for the sulphate of zinc.

By means of these solutions, wrought or cast iron, steel, lead, zinc, tin, and the alloys of those metals, either with each other or with bismuth and antimony, may with facility be coated with brass or bronze, after being scoured in a suitable manner, according to the nature of the metal. The operation is performed at the ordinary temperature. The article to be coated is put in communication with the negative pole of a Bunsen battery, the positive decomposing pole being a plate of brass or bronze.

When large surfaces are to be coated, experience has proved that it is requisite to increase the number of pairs of plates, and not their size.

When the articles have been coated, and have undergone the usual coloring process, they equal in beauty the finest bronzes.

Rough cast iron may, by these means, be made to assume a very beautiful appearance; and articles thus coated will be preserved from oxydation in the interior of habitations. With regard to those intended for the open air, they must be covered with a suitable varnish, in order to protect them. This process is recommended by M. Becquerel.

11. *New Property of Coke;* by JAMES NASMYTH, (Mining Journal, July 29, 1848.)—Having just read in your Journal of the 22d, some observations on the important experiments of M. Jacquelain, in reference to the conversion of diamond into coke, it occurs to me, that it may be interesting to some of your readers to be made aware of a discovery in close connection with this subject, which I made several years ago, and which Professor Faraday has done me the honor to communicate to the Royal Institution. The grand distinction between the discovery of M. Jacquelain and mine is simply this, that while he discovers that diamond can be made into coke, I had long since discovered that *coke was diamond;* in as far as that coke is possessed of one of the most *useful* and remarkable properties of diamond in respect to its power of *cutting* glass, owing, doubtless, to the extreme hardness of its ultimate particles, or minute crystals of which a mass of coke is formed. We are apt to consider coke as a soft substance, because we can crush it, and pulverize it with facility; but if we examine into the actual hardness of the minute, plate-formed, crystals, which compose a mass of that substance, we shall find that they are possessed of a most remarkable degree of hardness, and can *cut* glass with that clean looking cut which is so peculiar to the diamond. I use the term *cut* with all due consideration, in contra-distinction to the scratching property which is possessed by all substances harder than glass; but it will be found that coke does not scratch, but really and truly *cuts* the glass, which any of our readers may prove, by taking a small fragment of coke, and switching it at random, across and across, a pane of glass while the sun is shining through it, which will render the beautifully clear, diamond-like cuts more distinct; they will be found to penetrate pretty deep into the body of the glass, and give forth most beautiful prismatic colors, as the light of the sun falls on them. So far this may be all very pretty and interesting, as tending to still further identify the diamond with carbon; but, as I always like to have an eye to practical application of scientific discovery, I am anxious to make these facts known to your readers, so as, together with the following remarks, they may, peradventure, turn this discovery to some useful application; for, although I do not expect to see our glaziers using a cinder to cut the glass for the repair of broken windows, in lieu of a chip of the queen of gems, yet I cannot but feel certain that, when the extreme diamond-like hardness of coke is made known, that the fact will be laid hold of, and turned to good account as a most cheap material for all grinding purposes, such as required for many processes in the arts—to say nothing of its useful application to the sharpening of a razor, as a very superior strop powder, for which purpose, however, the coke must be reduced by *levigation* to the most minute and impalpable powder. I shall leave the matter of application in the hands of your readers, now that they are made aware of the fact which I have endeavored to communicate to them.

II. Mineralogy and Geology.

1. *New Locality of Idocrase, Anorthite? and Molybdenite;* by Prof. J. H. Webster, (communicated for this Journal.)—During the past summer I have discovered a new and very interesting locality of idocrase in York County, Maine. It is in the town of Sanford, about four miles north of the Wells railroad station, and about one mile east of Sanford meeting-house.

The idocrase composes a bed, (or vein?) extending upwards of two hundred feet in a direction north and south, projecting in several places a few feet above the soil. At one extremity it is bounded by granite, and at the other by trap. The thickness of this bed, or vein, could not be determined. The entire mass is idocrase in more or less perfect crystals, crossing one another and interlacing, or projecting into cavities. These cavities are here and there partially filled with white carbonate of lime and a few crystals of what will probably prove to be anorthite, with albite.

Since this discovery, further exploration has brought to light more perfect and brilliant crystals in white quartz, in the same field, at a distance of a few rods.

By the action of an acid, the carbonate of lime has been removed from several masses, and the crystals of idocrase uncovered present brilliant planes, and stand out in bold relief. The crystals are often finely terminated, and present the usual modifications of form; they vary in size from a tenth of an inch in diameter, to an inch and a half; part of one crystal that was unfortunately broken, is now two and a half inches in diameter, and four and a half in length.

Here and there I found molybdenum and epidote in the masses.

I have revisited the well known locality of beryls at Royalston, and after ten days labor with three men drilling and blasting, and removing some tons of the granite, obtained but half a dozen broken crystals. The old workings were thoroughly cleared out, and the termination of the original vein that afforded so many fine beryls, was arrived at. This spot I think may now be said to be exhausted.

During these operations, I found four crystals of feldspar of enormous size and beautifully perfect; one was found projecting from the granite twenty-three inches, and its diameter was eleven and a half inches. This was unfortunately broken in the attempt to disengage it; the terminal portion of ten inches in length, was however removed nearly perfect.

Cambridge, September, 1848.

2. *Lapis Lazuli and Mica.*—Both of these minerals are found near Lake Baikal, especially in the river Hindianka and all the rivers flowing from Mt. Khamardaban. The lapis lazuli is obtained in fragments from the valleys, and according to the natives, it is found after the heavy rains; but all attempts to discover its original locality has hitherto been unsuccessful. Mica is abundant and is used by the natives for windows in place of glass.

3. *Mica originating from Hornblende,* (in a letter to Prof. Silliman from T. H. Fergus, dated Westchester, Pa.)—In an examination of the

greenstone rocks near Boston, two or three years since, I observed the surface, where long exposed to the weather, to be covered with scales of mica, while the interior did not contain that mineral, but hornblende instead, I therefore surmised that the change had been wrought by some action of the atmosphere.

I selected specimens from the different portions of the rock and from several others, and on my return home experimented upon them with the blowpipe: I found that every specimen of hornblende, whether from the outside or the interior of syenite or any rock which contained that mineral, when presented to the inner flame, gave the result usually described in the books; but weathered particles of the hornblende, in the outer flame, took a lighter color, and when cold, the slightest blow caused them to separate into gold colored scales which presented every characteristic of mica.

4. *Meteoric Iron of Seeläsgen in Brandenburg.*—The Annalen der Physik und Chemie, von J. C. Poggendorff, Band lxxiii, Stuck 2, s. 329, (1848,) contains a brief notice of the discovery of a considerable mass of meteoric iron near the village of Seeläsgen, between Schwiebus and Züllichau in the provinces of Brandenburg. It had remained until lately unobserved beneath a heap of stones before the house of a farmer. It has an irregular roundish figure, with many deep pits or depressions, measures about a foot in diameter, and weighs (apparently) near two hundred pounds. It is black on the outside, though coated in many spots with hydrated oxyd of iron, perfectly compact within, homogeneous, and of a steel-gray color; and resembles so much in these points, as well as in its malleability, the meteoric iron of Braunau (Bohemia), that, in all probability, it possesses the same chemical composition. Prof. Duflos has already detected, in addition to the iron, the presence of phosphorus, nickel and cobalt. It is soon to receive a full and complete analysis. C. U. S.

5. *Carbonate of Copper and Zinc;* by Prof. A. Connell, (Jameson's Jour., vol. xlv, p. 36, July 1848.)—This carbonate from Matlock has a pale green color with a laminated structure and pearly lustre; it is disseminated in small portions through the matrix. Analysis afforded carbonic acid and water 27·5, oxyd of copper 32·5, oxyd of zinc 42·7, magnesia and lime, *a trace* = 102·7. This result may correspond to an atom of dicarbonate of copper and zinc combined with an atom of water or $2(Cu, Zn)\,O\,CO^2 + HO$; but the smallness of the quantity prevented the determination of the relative quantities of carbonic acid and water. This mineral seems to be either identical with aurichalcite or nearly allied to it.

6. *On the Occurrence of Ores of Mercury in the Coal Formation of Saarbrück;* by Herr Von Dechen, (Geological Journal, No. 14, p. 33.)—In a lecture before the Society of the Lower Rhine, Herr Von Dechen notices this singular fact. These ores are, in general, very rare, and, in this place, occur in the upper division of the carboniferous group in beds belonging to the productive coal formation, or even to a higher part of the series, in which previously they were not known to be found in any part of the earth. In this district they are confined to its eastern portion; Baumholder, in the district of St. Wendel, being the most western point where they have been found, the Kellerberg,

near Weinsheim, the most northern, Nack, near Erbeslüdesheim, the most eastern. They occur in veins in the normal beds of the coal formation, in the melaphyres, the amygdaloids, and the feldspar porphyries; these massive rocks lying within the range of the carboniferous strata. They are also found disseminated and in fissures in beds of sandstone of this formation, as at Münster-Appel and Waldgrehweiler, wholly unconnected with true veins. The association with the ores of mercury of certain claystones and hornstones, which are not in general found so much developed in this formation, is very remarkable. Within the limits mentioned, ores of mercury have been observed in thirteen different localities, some of which range in straight lines. The longest of these lines reaches from Katzenback, over the Stahlberg, Landsberg, near Obermoschel, to the Kellerberg, and is about fourteen (three German) miles in extent.

7. *Notes on the Mines of a portion of the State of Mexico;* by Lieut. G. W. Raines, U.S.N., (from the American Star, city of Mexico.)—The general method of mining is probably the same in most of the mines of Mexico; some point is selected in the vicinity of one or more veins, which indicate sufficient richness of ore, and contiguous to fuel and other necessaries, and whose elevation allows the water to be drawn off by subterranean passages, or adits, cut through the adjacent valley to avoid the great expense of drawing it to the surface. The perpendicular shaft is made of sufficient size to accommodate the ropes and bags, by which the ore is raised to the surface, by animals or machinery, and space for the ladders for the descent and ascent of the miners; and also for the pump apparatus, for clearing the mine of the copious streams of water, which, at a considerable depth, pour in from different directions, and the removal of which, constitutes one of the principal items of expense.

From this shaft, horizontal galleries are excavated in the direction of the vein, of a size large enough for the passage of the miners with ore; when the vein is reached, the rocky gangue containing the metal is blasted off, the fragments are broken up, and being placed in small bags about one foot in diameter, are then taken to the foot of the shaft; here some four or five are placed in a bag of skin, which being attached to the vertical rope, is thus drawn to the surface. When a horizontal gallery, or level, has followed the vein so far as to make the air impure, either a new gallery must be made, or a vertical aperture pierced for a proper circulation of the air; in large mines these ventilating shafts are numerous and expensive.

The ore having arrived at the surface, is carried to the pounding mills, where by the action of vertical beams of wood shod with iron, which are raised and let fall by machinery, it is reduced to powder: the coarser particles being separated by a sieve over which the powder falls, are returned to the mills for further action. The finely divided ore is then removed to a rolling or grinding mill, to reduce it to the finest possible state of division; at the works at Sanches, some four miles from Real del Monte, it is mixed with water and submitted to the rolling action, in a circular trough, of two solid cylinders of stone, similarly to the action of the mortar mill.

At Regla the powdered ore is also placed in a circular stone trough, in the centre of which a vertical shaft turns, with two horizontal arms, whose extremities have each a block of basalt attached by chains, which, in the rotary motion, is dragged round, grinding against the bottom and sides of the trough, and by which action, the wet ore is reduced to its finest state. At this stage of the process there are different methods for extracting the silver, depending on the richness of the ore, its constitution, and the fact that modern improvements are as yet but partially adopted.

First method. The wet powdered ore (or schlich) is mixed intimately with a certain proportion of common salt, (chlorid of sodium,) the amount depending upon the kind of ore, and the quantity of sulphur, &c. with which the silver is mineralized; the mass is then spread out on the floor of a reverberatory furnace, and there kept in a red hot state for about six hours. By this means, a portion of the sulphur is driven off in the form of sulphurous acid gas, whilst the remainder unites with the sodium, and the chlorine with the silver; thus the result is a combined mass of chlorid of silver with sulphuret of sodium. The mass is then mixed with salt and water, and placed in revolving barrels, with pieces of iron and a quantity of mercury—about two hundred weight in fifteen hundred pounds of the mass; at the end of about twenty-four hours, it is found that the chlorine of the chlorid of silver has united with the iron, and the silver thus reduced is with the mercury. This amalgam of silver is then washed free from the other substances, which are either dissolved or carried off by the current; it is then pressed in close canvas bags, which thus remove the superabundant mercury; the semi-solid mass is then moulded in iron triangular forms, and distilled in an iron vessel, which separates the mercury and the silver remains pure.

In this process,—which is employed for the poorer ores,—about four ounces of mercury are lost in obtaining eight ounces of silver; this loss arises principally from the oxydation of the sulphur, &c., which being converted thus into acids combine with the mercury, and the resulting salts are carried off in the washings.

Second method. The wet powdered ore is intimately mixed with common salt and pieces of copper, or the protochlorid or sulphate of copper, and a quantity of mercury; the wet mass is spread out on a floor of boards in the open air, about six or eight inches in thickness, and mules are occasionally driven over it, for the purpose of thoroughly mixing the ingredients as the chemical action proceeds.

In not less than twenty days, the process is completed, when it is found, that by the action of the air and moisture, the sulphur has been oxydized at the expense of both, and the hydrogen of the water uniting with the chlorine of the copper or sodium, has formed hydrochloric acid; and any portions of chlorid of silver, formed in the process, are reduced to the metallic state by the copper. The whole is then well washed, when nothing remains but an amalgam of silver with the pieces of copper.

The foregoing is the principal process for the extraction of the silver at most of the mines of Mexico, though mostly applicable to the poorer ores; the loss of mercury, which is probably much greater than that

by the preceding process, is an objection, though it has the advantage of being applicable on a larger scale, and requires no fuel but for the distillation of the amalgam; it is the old method.

Third method. The finely divided ore is roasted with common salt as in the first method, then placed in a vat with salt and water; the silver is thus converted into a chlorid, which is stirred up and then passed into a smaller vessel, to collect the heavy earthy particles, and thence into a third, where pieces of copper cause a decomposition of the chlorid of silver, the pure metal being precipitated and a chlorid of copper formed; this is passed into a fourth vessel where fragments of iron cause a precipitation of the copper. By this process, which is simple, the copper—of which there is generally a considerable quantity—is also saved; it is as yet employed but on a small scale at Sanche, near the mine of Moran, to test its value.

Fourth method. The fine powder from the pounding mills is mixed with lime, scoria, iron and oxyd of lead (litharge), and then thrown into a smelting furnace with alternate layers of coal; a portion of the sulphur combines with the oxygen of the lime and litharge, and with the iron, passing off in the first two cases as sulphurous acid gas, and in the third forming sulphuret of iron; whilst the remainder, uniting with the base of the lime, forms sulphuret of calcium; this with the scoria forms a melted mass, which falls to the bottom of the furnace, and flows off at a lateral orifice. By this process the silver is reduced to the metallic state, but as the amount is small and disseminated through the mass, it would, to a considerable extent, be carried off by the scoria and lost; hence the lead is employed, to collect the particles of silver and thus form an alloy, which flows out at the lower portion of the smelting furnace.

This alloy is now placed in shallow basin furnaces, and whilst in a melted state, strong currents of air are forced over its surface, which oxydize the lead and with it all the baser metals, and the silver remains pure; the dross being blown away by the draughts of air. This is the best process for the rich ores, and in the works of the English mining company, is, I believe, always employed for their reduction.

The silver is frequently alloyed with gold, which, when of sufficient value, is separated at the mint, and after deducting expenses, the remainder is returned in coin to the owners.

III. Zoology.

1. *On the Structure of the Jaws and Teeth of the Iguanodon;* by Dr. Mantell, (Proc. Royal Society; Lit. Gaz., London, June 17, 1848.)—The recent discovery of a portion of the lower jaw with teeth of an adult Iguanodon, having enabled the author to obtain decisive evidence as to the structure of the maxillary organs of that gigantic herbivorous reptile, the results of his investigations are embodied in the present communication. The first memoir on the teeth of the Iguanodon was published in the "Philosophical Transactions for 1825;" but, owing to the fragmentary and water-worn condition in which bones of terrestrial vertebrated animals occur in fluviatile deposits, from their being composed of materials transported from far-distant

lands by powerful streams and currents, nearly a quarter of a century elapsed before any portion of a jaw retaining teeth was discovered. The most important relic of this kind is described in this memoir; it consists of the anterior part of the right side of the lower jaw, comprising about two-thirds of the dentary bone, and was discovered by Captain Lambart Brickenden, who, in the true spirit of a man of science, liberally placed it at the disposal of Dr. Mantell, as the original discoverer of the fluviatile origin of the wealden formation of the south-east of England.

This bone is eighteen inches long; and if the proportions of the maxillary elements in the Iguanodon were the same as in the recent Iguana, the entire jaw must have been four feet in length. It contains several of the new or successional teeth in their natural position, and there are sockets in the alveolar plate for nineteen or twenty mature molars; but all these teeth are wanting, having evidently been dislodged before the bone was imbedded in the stone. The mature teeth, which in their abraded state resemble those of the used molars of herbivorous mammalia, appear to have been arranged in a closely set series. The teeth in the lower jaw were placed with their flat enamelled striated face towards the inside of the mouth, while those in the upper were disposed in the opposite position—namely, with the enamelled ridged face of the crown externally; and the teeth of the upper and lower series were subalternate or intermediate in their relation to each other, as in the ruminants.

The anterior part of the lower jaw, which forms the symphysis, presents a most remarkable deviation from all known reptilian types; the alveolar parapet, instead of being continued round the front of the mouth, and bearing teeth, as is the case in all saurians, is edentulous, and at the distance of four or five inches from the front of the chin, suddenly contracts in a vertical direction, becomes procumbent, and expands horizontally to meet the corresponding portion of the opposite ramus of the jaw: the two symphysial portions when united, forming a deep scoop, bear considerable analogy to the corresponding part in the Edentata, especially in the extinct colossal Mylodon.

Along the external surface of the jaw there is a row of very large vascular foramina; and the symphysial margin is also perforated by numerous similar openings for the passage of blood-vessels and nerves to the integuments and lips—a certain indication of the great development of the soft parts which covered the maxillary organs. The upper jaw, of which a considerable part, collected by the author, is now in the British Museum, confirms the inferences deduced from the examination of the lower jaw and teeth. The author, with the able assistance of Dr. Melville, instituted a comparison between the fossil teeth in his own, and in the British Museum, with those of existing lizards, and the result of their labors is fully detailed in this memoir.

The light shed on the structure and functions of the dental organs of the Iguanodon by these recent discoveries, confirms in every essential particular the inferences deduced by Dr. Mantell from the detached teeth alone, and detailed in his memoir in 1825; and it also reveals the remarkable fact, that this saurian herbivore, which equalled in bulk the gigantic Megatherium and Mylodon, and was destined, like them, to

obtain support by the comminution of vegetable substances, was also furnished with a large prehensile tongue and fleshy lips, to seize and retain the foliage and young branches which constituted its food.

Among the many extraordinary deviations from known forms disclosed by palæontology, there is not one more remarkable than this modification of the type of organization peculiar to the class of reptiles, to meet the exigencies required by the economy of a lizard, placed under similar conditions with the colossal Edentata of the tertiary periods and the herbivorous mammalia of more modern times, and designed to hold the same relative position in the economy of nature.

From the recently discovered specimens, the author states he has been able to determine that the portion of a lower jaw of a Saurian, with numerous fangs of teeth, described in his memoir in 1845, as probably that of a young Iguanodon, belongs to a distinct genus of the same family; and he proposes to distinguish it by the name of *Regnosaurus Northamptoni;* the specific designation being a tribute of respect to the noble President of the Royal Society.

2. *Notice of Fragments of Trilobites of gigantic size in the Cabinet of Dr. Julius S. Taylor., Carrollton, Montgomery County, Ohio.* —During the year 1847, Dr. Taylor kindly furnished us with a cast of the most remarkable fragmentary portions of the "Isotelus megistus" that we have ever seen. A notice of which we inadvertently failed to give at the time of the donation.

Dr. Taylor said, "that the specimen from which this cast was made was found in the blue limestone resting upon a stratum of greenish 'marlite' clay," about fifty feet from the upper surface of the blue limestone, which limestone is said to be the equivalent of the Trenton of New York and Silurian of England.

The cast presents five or more portions of the shield, the post-abdomen and other portions of the Isotelus which bear the most indubitable evidence of having belonged to trilobites of the most gigantic size on record. Professor Locke, M. DeVerneuil and other scientific gentlemen having visited my cabinet concur this opinion.—(I am indebted to Professor Locke for the cast.)

At the time of my finding the specimens, I also found *portions* of at least one hundred different individuals of the same species, varying in size from one half an inch to six inches in length, proving, that the trilobites like the limulus were gregarious. In connection with this specimen, I also found a most delicate and beautiful "Retepora," entirely new, which has been described and figured by my friend, John W. Van Cleve, Esq., of Dayton, and called "Retepora nitida."

We have also received from Dr. Taylor, years ago, a full suite of fossils descriptive of the geology of the county of Montgomery, Ohio, in a most beautiful state of preservation, of which he informed us that he had numerous duplicate specimens which he would most gladly exchange for fossils or minerals of any other section of country.

3. *Water Tubes in Fishes*, (Proc. Bost. Soc. Nat. Hist., April 19, 1848, p. 27.)—Prof. Agassiz made some remarks on the existence of numerous minute tubes in fishes, opening externally, which have hitherto been considered mucous tubes, but which he is convinced are tubes for the introduction of water into the body. These openings in some

fishes are extremely numerous, existing over the whole external surface. In freshwater fishes, and in those living in shallow waters, they are comparatively few. They are most numerous in fishes which swim at great depths.

In reply to a question of Dr. Wyman, he said that he had not as yet found them in the sharks and rays. These openings are sometimes visible to the naked eye, and sometimes require a magnifying power for their detection. They are very large and numerous, and easily seen, in the head of the common shad. These minute tubes unite into larger ones, in a manner which seems to be the same in each class. He thought this circumstance might be of some value in the classification of fishes. The tubes grow larger and larger as they approach the heart. They open into the circulating system near the heart. Prof. A. had injected the heart through these tubes, and had drawn blood from them by a syringe. He had injected the external surface through a *single* tube, and that whether opening near the head or the tail, or in other parts of the body. He believes these tubes an apparatus for the safety of fishes living at great depths, to enable them to resist the pressure to which they must there be subjected. He did not deny the existence of mucous tubes in fishes, for there are such, about the heads of sharks for instance, from which mucus may be obtained by pressure; but he is sure, that what have been hitherto considered as mucous tubes, are in reality water tubes.

4. *Structure of the Foot in Embryo-Birds*, (ibid, June 7, p. 42.)—Prof. Agassiz had recently made some observations on the structure of the foot in the embryo of birds, which he thought would throw new light on the classification of birds, and perhaps call for radical changes in the system now in use. He had examined the feet of the embryo of *Turdus migratorius*, *Hirundo riparia*, *Sylvia æstiva*, and *Fringilla melodia*, and found the following appearances in all.

The four toes, which in the mature bird are separate, three being directed forwards and one backwards, are in this state all directed forwards, and webbed. There is as yet no trace of bone in them; there are only rows of cartilaginous cells in the position to be occupied by bone, which are more closely grouped together at the points where the joints are destined to appear. The lower extremity is, in fact, at this time, a fin. The upper extremity is in a similar condition, presenting, however, only three rows of cartilaginous cells, united by a membrane. As this condition of the extremities exists in different families, Prof. A. thinks that the present grouping of all web-footed birds together, may be incorrect; particularly since they differ as much among themselves in other respects as they do from land birds. He found that the bill of the immature robin resembled that of a vulturine bird, being straight near the base, and curved at the extremity, the upper mandible being longer than the lower. This would seem to indicate that the vulturine form is a lower type than it has usually been considered. This appeared to derive confirmation from the great resemblance of the bill of some of the water birds to that of some of the vulturine family, that of the genus *Lestris*, for example. Some of the birds of prey also have another point of resemblance to water birds, in a rudiment of a web between two of the toes. Hereafter, birds having all their toes direct-

ed forwards, must be regarded as of a lower type than those which have one directed backwards; as, for instance, the pelicans and cormorants among water birds, and the genus *Cypselus* among swallows. From the result of his examinations of the embryos of birds, Prof. A. had recently, before a scientific society, ventured to predict that hereafter, among the higher mammalia, the foot of the embryo would in the same way be found to be webbed, like that of the seals and cetacea. Prof. Jeffries Wyman immediately afterward confirmed the truth of the prediction in the case of the fœtus of a cat. A similar appearance had been figured as existing in the human embryo, but its philosophical bearing had not been before noticed.

5. *American and European Oyster-catcher*, (ibid, p. 43.)—Dr. Cabot read a statement of the comparative measurements of the American and European oyster-catcher. His observations tend to confirm the opinion of the distinctness of the two species, which have sometimes been confounded with each other.

	Hæmatopus palliatus. Female. inches.	*Hæmatopus ostralegus.* Female. inches.
Length from tip of bill to tip of tail	21	18¼
Extent " " " "	36	32⅜
Length of tongue	⅝	⅞
Œsophagus to proventriculus	7⅖	7
Proventriculus in length	1	1⅛
Intestines to vent*	40	59
Cœca enter intestine at	2½ from vent.	3
Length of cœca	2¾	4⅛
Trachea to bronchi	4 12/16	4 1/16
Keel of sternum in depth, not quite	1	1
" " in length	2½	2¼

6. *Dr. M. Barry's Physiological Discoveries*, (Jameson's Jour., July, 1848, p. 194.)—In the last number of the British and Foreign Medical Review, edited by Dr. Forbes, a distinguished physiologist has the following remarks in regard to Dr. Martin Barry's important physiological discoveries:—

"The writer of the remarks in question, after shewing the importance of the combination of anatomical and physiological investigations with zoological researches, states that M. Milne Edwards, in several of his later Memoirs, 'has even adopted the principle, that embryology affords our best and surest guide in classification; as it is by the study of development that we are enabled most certainly to distinguish between those *essential* characters on which affinity depends, and those *accessory* characters which are engrafted (so to speak) on the original type for some special purpose. This doctrine was first formally enunciated by him in a Memoir on the Principles of the Natural Classification of Animals, published by him in 1844:† in which he points out that the condition of the earliest germ of all animals is the same; namely, the simple cell: that the earliest phases of its development differ according to the sub-kingdom to which it belongs, whether radi-

* A very minute remnant of vitelline duct found at 18¾ inches from vent.
† Annales des Sciences Naturelles, iii Ser., Zool., tome i, p. 65.

ated, molluscous, articulated, or vertebrated, and that the distinctive characters of these *sub-kingdoms* are consequently those first evolved; —that, in the further progress of development, the characters of the *classes* next present themselves, then those of the *orders*, then those of the *families*, *genera*, and *species* consecutively, and lastly those of the *individual*. We are quite sure,' continues the writer, 'that Professor Milne Edwards could not have been aware that he had been completely anticipated in this doctrine by Dr. Martin Barry; or, with his accustomed candor, he would have alluded to the circumstances.'

"Dr. Barry's views, contained in two papers in Professor Jameson's Edinburgh New Philosophical Journal for January and April, 1837, are most clearly expressed. * * * In the first of these papers, he works out the important principle of Von Baer,—that 'a heterogeneous or special structure can arise only out of one more homogeneous or general, and this by a gradual change;' and applies this to the different *directions* of development, which present themselves in the primary subdivisions of the animal kingdom at a very early period of the history of the embryo, pointing out at the same time (as M. Milne Edwards has subsequently done) that this fact completely negatives the idea that the vertebrated animal ever passes through the conditions which are characteristic of the radiated, the molluscous, or the articulated. He further shews that the order in which the distinctive characters of the germ are evolved, is that of their generality in the animal kingdom. 'Thus, in development, the structure characteristic of the *vertebrata* only cannot manifest itself until there has been assumed essentially a structure common to *animals*, of which the vertebrata are but a part, and to whose type the type of the vertebrata is subordinate. In like manner, structures subordinate to the type of the vertebrata cannot manifest themselves, until after a modified appearance of the *general type*, of which they are but partial metamorphoses. More and more special forms are thus reached in succession, until the one most special is at length attained.' In his second paper, he expresses this view still more clearly, in the following table of the history of development of any single organism:—

1. No *appreciable* difference in the germs of all animals (fundamental unity.)
2. The *class* manifest, but the *order* not distinguishable.
3. The *order* manifest, but not the *family*.
4. The *family* manifest, but the *genus* not known.
5. The *genus* obvious, but not the *species*.
6. The *species* manifest, but the *variety* unpronounced.
7. The *variety* obvious, but the *sexual* difference scarcely apparent.
8. The *sexual* character obvious, but the *individual* character obscure.
9. The *individual* character in its most special form.

"In both papers, Dr. Barry continually puts forth this principle as the groundwork of classification. Thus he says: 'The only sure basis for classification is—not structure, as met with in the perfect state, when function tends to embarrass, but—the *history of the development*, at that period when structure presents itself alone.' And again: 'the fact is, that naturalists have begun just where they should have ended.

They have attended to details, but neglected general principles. Instead of analyzing, their process has been one of synthesis. Their attention has been directed to the grouping of the twigs,—as if they were thus to find their natural connexions, without even looking for assistance towards the branches, or the trunk that gave them forth. But the simile is inadequate; the labor lost has been greater than even this supposes. For in the *grown tree* of *animal* structure, parts, once essentially the same, have not only diverged in their development, and become elaborated into very different forms,—but, as before said, perform very different functions also. Hence a positive in addition to a negative source of error. But what other course *could* naturalists have taken? Truly none: their 'circumstance' allowed no other. It is only now that a way is beginning to be opened, by which it may, by and by, be possible to proceed in an opposite direction, viz., from trunk to branches and twigs. This, if ever accomplished, must be by means of the *History of Development* or *Embryology*.'

"We have thought it right to bring forward Dr. Barry's claim as the first distinct enunciator of this doctrine, because we perceive that its truth is being more and more generally recognized, and that it must ultimately become the foundation of all philosophical zoology."

IV. Astronomy.

1. *Observations during the Lunar Eclipse, September* 12, 1848; by Lewis M. Rutherford, (in a letter to the Editors, dated New York, Sept. 28, 1848.)—In the course of some observations made during the occurrence of the lunar eclipse, on the night of the 12th inst., I was struck with the arrangement of the colors visible in the earth's shadow. In the penumbra, I could not detect the prevalence of any particular one of the prismatic hues, but it appeared as a mere diminution of the moon's brilliancy, without any apparent change of color, except a grey shade as it deepened immediately preceding the true shadow. The shadow of the earth had a diameter not far from three times that of the moon; and if it had been projected upon a plane surface of uniform color, sufficiently large to present the whole at one view, it would have appeared with a circle in the centre, rather less than the moon, of a deep red copper color; the reddish tinge of this central disk was plainly visible to the unassisted vision, became much plainer in a telescope of three inches aperture, and with one of six inches, the red almost predominated over the brown in the copper hue. This disk was surrounded by a belt of yellowish orange, leaving a margin of greyish green occupying rather less of the diameter of the shadow than the annulus of yellowish tinge: these three divisions, although shading gradually into each other, were almost as well defined in their limits as was the exterior of the shadow itself, and although not at all comparable to the solar spectrum as shown by an ordinary prism, in clearness and brilliancy of color, were yet too apparent to have been overlooked by the most casual observer, the first two being easily seen by the naked eye, and the last detected by the slightest optical assistance, and all evincing a remarkable increase of depth and individuality as a larger aperture was applied.

The translucent atmosphere which surrounds the earth, in this case acting as a spherical lens, refracted the sun's rays to a focus at some point between us and the moon, and in this process dispersed them into their primary colors; and these having crossed at the focal point, we find, as might have been expected, the red or least refrangible ray covering the centre of the disk, surrounded in the proper order of refrangibility by the orange, yellow and green; but in no part either of the umbra or penumbra, could I detect any traces of the remaining colors of the spectrum, the blue, indigo, or violet. It was the absence of these tints which struck me as remarkable, and as being a subject upon which I had never met with any remarks either of notice or explanation; in the few printed accounts of lunar eclipses which I have seen, not one of the observers has mentioned the occurrence of any of the blue tints, while all have noticed the green, orange and copper red, although without speaking of their order as portions of the spectrum, or noticing the absence of the remaining three. The appearances above detailed, brought to my recollection a circumstance before observed but never heeded. It is this, that in looking at one of the planets or a bright star within a few degrees of the horizon, with a reflector or well corrected achromatic, the object is tinged with prismatic colors, the red, orange, yellow and green being very bright, while the others are absent as in the case of the lunar eclipse. I am unable to suggest any mode of accounting for these phenomena, which is exempt from strong objections; the most obvious are the following. The violet, indigo and blue rays being much the most refrangible, may be lost by being thrown so far from the umbra of the earth, as to be unseen in the brilliancy of that part of the moon which receives the full splendor of the sun; this would be the case with the extreme violet ray, which would precede the green by a distance nearly equal to the interval between it and the red, and consequently would be well without the circle of the penumbra; this would not be the case however, with the indigo, and still less with the blue, which last would (if it occupied its proper proportionate space in the concentric prismatic annuli) adjoin the green in that part of the penumbra which is so dark, as readily to betray the preponderance of any color, it being in truth difficult to mark the line which separates the shadow from the penumbra. The only other hypothesis which occurs to me is, that the earth's atmosphere, although to us transparent, has in reality an intrinsic color, such as would be formed by the combination of red, orange, yellow and green; in consequence of which these colors are transmitted, while the others are absorbed: the same cause may operate to impart to the heavenly bodies, when near the horizon, the ruddy hue they always wear when setting or rising; and it will be remembered, that a ray passing from the sun along the surface of the earth, and reaching by refraction the umbra on the moon, passes through an extent of atmosphere double that traversed by any ray which reaches us from the rising sun, and would consequently render much more visible the effect of chromatic absorption, if it existed. The objection to this theory, is the blue vault above us often deepening into an indigo, and always too palpable to be explained away by any theory of complementary colors. The night of the 12th was beautifully clear and quite cold, and as the silver surface

of the moon was veiled, the milky way and the smaller stars gradually shone out, the nebula in Andromeda and the cluster in Hercules became visible to the naked eye. Saturn was within a few degrees of the moon at the time; before the commencement of the eclipse, with my largest telescope the ring could with difficulty be discerned, with but two satellites. During the period of the moon's greatest obscuration, the planet seemed pierced by a bright silver wire of infinite tenuity, attended by five satellites, one of which was impaled upon the following ansa of the ring, but moved off with very appreciable speed.

I will not trouble you with the time at which the various points of the eclipse occurred, as they are at best but rough and useless subjects of observation. I would however trespass a little further upon your indulgence, while I say something of the instrument with which these observations were made. My largest is an achromatic telescope, equatorially mounted, of six inches aperture and eight feet focus. The object-glass is the workmanship of Mr. Henry Fitz of this city, an optician of great skill and rising reputation; the flint glass, which is quite pure, he obtained from Guinand's establishment in Paris. I believe this object-glass to be free from aberrations, both spherical and chromatic, saving the secondary spectrum which is present in all achromatics in proportion to their apertures; its light is sufficient to shew plainly under favorable circumstances, the stars called by Capt. Smythe, in the Bedford catalogue, the 16th magnitude, and which he says are only caught by occasional glimpses under the most favorable circumstances by his instrument. It renders the companion of α Lyræ, and the fifth star in the trapezium of Orion, visible under sufficient illumination for micrometric measurement; its defining power enables me to see the rugged cliffs and volcanic chasms of the moon most beautifully; it has shewn me at one time last winter, the disk of Jupiter covered with small belts, in addition to the two usually seen, while two of his satellites were plainly seen projected upon the planet's disk, followed by their shadows, which were as distinct as black wafers upon white paper, the difference in their magnitude being easily seen without measurement; it very much elongates η Coronæ, and enables me readily to measure the position and distance of the close pair of the triplet of ζ Cancri with a power of 200, which is the highest my micrometer is provided with. I take great pleasure in bringing to your notice, the workmanship of Mr. Fitz, as he is an American and a self-taught artist, who places within our reach at home, those instruments which heretofore have been obtained from abroad, at a great cost.

2. *Eighth Satellite of Saturn.*—An eighth satellite of the planet Saturn has recently been discovered by Mr. Bond, of the Cambridge Observatory. Its orbit is exterior to that of *Titan*, which (in Sir J. Herschel's new nomenclature of these satellites) is the bright satellite discovered by Huyghens, and hitherto supposed to be the most remote but one from the planet.

3. *New Comet.*—Dr. Petersen, of Altona, discovered a new telescopic comet on the 7th of August, 1848.

4. *Elements of the orbit of the Planet Hebe*, (Comptes Rendus Acad. Sci., July 10, 1848.)—M. Yvon Villarceau, from a discussion of all the observations he could procure, has deduced the following elements of Hebe.

Mean anomaly, July 0, 1847, m. t. Paris,	272° 29′ 25″·0	
Longitude of perihelion, . . .	14 52 34 ·1	M. eqx.
" " ascending node, . .	138 30 55 ·5	July 0.
Inclination, ...	14 46 56 ·1	
Angle of excentricity, . .	11 31 52 ·7	
Mean daily heliocentric motion, . .	939″·3097	
From which are derived,		
Excentricity, ...	0·1999033	
Semi axis major, . . .	2·4254844	
Time of sidereal revolution, .	3 yrs. 777447	

5. *Elements of the Planet Metis*, (Institut, July 12, 1848.)—Mr. Graham, of Markree, Ireland, has furnished the following elements of the planet Metis, discovered by him, April 25, 1848. It is his second approximation, and is based on the observations made at Markree, April 26, May 5 and 19.

Epoch, 1848, May 0·0, m. t. Greenwich.

Mean anomaly, ...	141° 54′ 11″·82	
Longitude of perihelion, . .	72 50 8 ·16	M. eqx.
" " ascending node, . .	68 29 40 ·44	May 0.
Inclination, ...	5 35 23 ·98	
Angle of excentricity, . . .	7 13 36 ·92	
Log. of semi axis major, . .	0·3777174	
Mean daily motion, . . .	962″·5660	
Period of sidereal revolution, .	1346 days.	

6. *Speculations on the next Planet beyond Neptune;* by M. Babinet, (Institut, Aug. 23, 1848.)—The fact that the planet Neptune differs so essentially in its orbit and mass from the theoretical planet of Le Verrier and Adams, induced M. Babinet to undertake an investigation, having for its object to ascertain if the perturbations in the motions of Uranus could be made to indicate a second exterior planetary body, which with Neptune should explain all the anomalies.

Assuming that the effects of the theoretical planet of Le Verrier are the resultant of the combined action of Neptune and another planet more distant, M. Babinet proposes this problem. "Admitting as exact the mass, distance, period, position Jan. 1, 1847, of the theoretical planet of Le Verrier, by what union of two other planets, of which Neptune shall be one, can this theoretical planet be replaced, in order to obtain the same resultant effect; and consequently what must be the mass, the distance, the longitude, and the apparent size of a new planet which combined with Neptune, will represent the theoretical planet of Le Verrier?"

M. Babinet gives the following results of his investigations, as probable within certain limits.

1. The planet complementary to Neptune is in mass, size, and brilliancy, at an equal distance, little different from Uranus. *Hyperion* is proposed as its name.

2. Its distance from the sun is forty-seven or forty-eight times that of the earth's distance.

3. Its period of revolution is double that of Neptune, as that of Neptune is double that of Uranus.

4. At any given epoch, its heliocentric longitude is equal to the longitude of Neptune Jan. 1, 1847, viz. 327° 24′, diminished by the quantity 1° 53′, and also by half of the quantity $n - 327° 24'$, which is half of the arc of longitude traversed by Neptune from Jan. 1, 1847, to the given epoch.

5. The brilliancy of the planet may be presumed to be equal to that of a star of the 10th or 11th magnitude.

6. If the planet is found in the position indicated, we may empirically substitute for the law of Bode, the law of double revolutions for the planets exterior to Saturn.

7. A planet yet more distant, with a period of 672 years, and a distance of 77 from the sun, would probably not appear larger than a star of the 18th magnitude, and could with difficulty be found by direct observation.

In remarking upon this communication, M. Le Verrier states that he had been engaged in similar researches, but he had abandoned them when he found that the planet Neptune completely satisfied the theory of Uranus. He saw no reason to believe in the existence of such a planet as M. Babinet supposes, or to warrant astronomers in searching for it.

7. *Shooting Stars of August* 10, 1848.—In our last number, (see p. 279,) we gave the observations made at New Haven upon the shooting stars of August 10, 1848, which showed that the meteors appeared at that season in their usual abundance. Observations made in France give the same result. M. Coulvier Gravier, with an assistant, counted on the night of August 9–10, 1848, from $11^h\ 30^m$ to $12^h\ 30^m$, *eighty-six* shooting stars: the whole number counted from $11^h\ 30^m$ to $2^h\ 45^m$, was *four hundred and fourteen.* For the sake of comparison, M. Gravier gives the following observations made at the same hour of night, viz. $11^h\ 30^m$ to $12^h\ 30^m$.

July 26, . .	22 meteors.	Aug. 6, . .	27 meteors.
" 27, . .	15 "	" 7, . .	30 "
" 30, . .	25 "	" 8, . .	40 "
Aug. 2, . .	17 "	" 9, . .	86 "
" 5, . .	16 "	" 10, . .	81 "

These observations confirm the statements heretofore published in this Journal, that shooting stars increase in frequency during several days, becoming most abundant about the 10th of August, and after that decrease at a similar rate.

V. Miscellaneous Intelligence.

1. *Electricity, as applied to Telegraphic Purposes*, (Mining Journal, June 3, 1848.)—On Wednesday evening last, at the Royal College of Chemistry, Dr. Ryan delivered a lecture on the above subject, to a full and attentive audience. He introduced his lecture, by observing—that electricity could no longer be considered an abstract, or separate science; as, during the past few years, every discovery had proved that the whole phenomena were the results of chemical action, and it must be considered therefore, a branch of the science of chemistry.

In treating of this subject, the researches in which, had presented so many advantages to civilized life, particularly as to rapid means of communication and its results, he should have to consider it under four different heads:—1. Those telegraphs which were worked by free or frictional electricity.—2. Those employing a current of electricity from a voltaic battery.—3. Those which are worked by electro-magnetism, induced by a voltaic battery. 4. Those operated on by magneto-electricity.—Dr. Ryan then alluded to the process of obtaining a current of frictional electricity, by rubbing glass, shellac, sealing-wax, &c., so well known as to require no repetition; he then went into some statistical data, as to the progress of electric telegraphs. In 1744, the Germans employed this electricity in striking bells; in 1746, Granarth gave a shock to twenty persons at a great distance; Winkler and Monin passed a current through 4000 feet of wire, the water in the basin of the Tuilleries forming part of the circuit; in 1746, the celebrated Dr. Watson passed a current through four miles of wire, water forming half the circuit, and he observed that no time appeared to elapse during the passage of the shock. In 1787, Lomonde, in France, constructed a telegraph, by the aid of an electroscope at the end of the conductor, to be communicated with, in which two pith-balls covered each of the letters of the alphabet.* On completing the circuit at one end with any particular letter, the pith-balls were repelled, and opening asunder, showed a similar letter at the other end, and thus gave a means of communication; and, in 1793, the luminosity of electricity, on tin-foil letters, was proposed for telegraphic purposes. In 1798, Dr. Salva, in Spain, constructed an electric telegraph, between Madrid and Aranjuez, twenty-six miles, which must, at that time, have been a great and bold undertaking. The lecturer came now to the year 1800, which he described as a most important period, as it produced the investigations and correspondence between Galvani and Volta, which developed the properties of electricity from a metallic battery, and has immortalized their names. The difference between frictional and galvanic or voltaic electricity, was one of the most interesting considerations in natural philosophy. In 1803, Bassi passed a current of voltaic electricity through 4000 feet of water; in 1809, Sœmmering constructed a telegraph on the principle of the powers of voltaic currents in decomposing water; he had a number of small glass tubes inverted over a pneumatic trough, and representing the several letters of the alphabet, or conventional signs; and on completing the circuit, the water immediately sinking in any tube, showed the letter, or sign, communicated, which was easily and quickly read off. In 1803, Ronalds, of Hammersmith, constructed a telegraph by galvanism, through coils of eight miles of wire, a description of which he published at the time.† In 1817, the celebrated Wedgewood also formed a voltaic telegraph; but no descrip-

* Here should also have been noticed the attempts of Lesage in 1774, who made a telegraphic instrument, consisting of twenty-four insulated wires, terminating at one end in a pith-ball electroscope. (See Encyc. Amer. Sup.)—Eds.

† In 1810, Dr. Coxe passed signals along a wire a mile long, extended around his lecture room at the University of Pennsylvania, and proposed to use it as a telegraph, by producing chemical changes on prepared paper. His proposal was published in 1816, in Thomson's Annals of Philosophy. Ibid.—Eds.

tion of it appears to be extant. Soon after this, Oersted, of Copenhagen, and Ampère, discovered the properties of this electricity, in deflecting the magnetic needle from the magnetic meridian to a position due east and west, or at right angles with it. This laid the foundation for the several sytems of telegraphic communication which he should then proceed to describe. In 1837, Professor Wheatstone had greatly improved his telegraph by reducing the number of needles to five, which have since been reduced to two. The lecturer then proceeded to describe the various modes of communication adopted by Bain, Wheatstone, Brett and Little, and Gamble and Nott, the latter of which worked entirely by electro-magnetism.

[Prof. Morse's method, brought forward in 1837, should have been added; it is far better than any here mentioned, and is beginning to be adopted in England.]

2. *The Dead Sea Expedition*, (Southern Literary Messenger, for September, 1848.)—This Expedition, under Lieut. Lynch, after encountering many difficulties in transporting their two boats, finally reached the sea of Galilee. Here they purchased a small boat and with the two "Fannies"* they pursued their course down the Jordan. There were many dangerous rapids in their way; but they passed safely and reached at last the Dead Sea.† We continue this notice by citations from an interesting article in the Southern Literary Messenger for September, 1848.

The water of the river [Jordan] was sweet to within a few hundred yards of its mouth. The waters of the sea were devoid of smell, but they were bitter, salt, and nauseous.

"As we rounded to the westward," writes Lieut. Lynch, "the agitated sea presented a sheet of foaming brine. The spray, separating as it fell, left incrustations of salt upon our faces and clothes, and while it caused a pricking sensation wherever it touched the skin, was above all exceedingly painful to the eyes.

"The boats heavily laden, struggled sluggishly at first, but when the wind freshened to a gale, it seemed as if the bows, so dense was the water, were encountering the sledge hammers of the Titans, instead of the opposing waves of an agitated sea.

"At the expiration of an hour and a half, we were driven far to leeward, and I was compelled to bear away for the shore. When we were near to it, and while I was weighing the practicability of landing the boats through the surf, the wind suddenly ceased and with it the sea rapidly fell—the ponderous quality of the water causing it to settle as soon as the agitating power had ceased to act. Within five minutes there was a perfect calm, and the sea was unmoved even by undulations. At 8 P. M., weary and exhausted, we reached a place of rendezvous upon the northwestern shore."

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* "Fanny Mason," and "Fanny Skinner," the names of their two boats. The former of copper, and the latter of iron.

† The descent of the Jordan is estimated by Lieut. Lynch, at six feet per mile. "The great secret of the depression between Lake Tiberias and the Dead Sea, is solved in the opinion of Lieut. Lynch, by the tortuous course of the Jordan. In a distance of about sixty miles that river winds along through a course of about two hundred miles. Within that distance he and his party plunged down no less than twenty-seven threatening rapids, besides many others of less descent."

The three succeeding days were devoted to sounding.

Resting over Easter Sunday, the party resumed operations the next day, making topographical sketches as they went, and touching at a copious stream issuing from hot springs, and the mouth of the river Amon of antiquity. They proceeded thence by degrees to the southern extremity of the sea, where the most wonderful sight that they had yet seen awaited them.

"In passing the mountain of Uzdom, (Sodom,) we unexpectedly and much to our astonishment," continues our adventurous explorer, "saw a large, rounded, turret-shaped column facing towards southeast which proved to be of solid rock salt, capped with carbonate of lime; one mass of crystallization. Mr. Dale took a sketch of it, and Dr. Anderson and I with great difficulty landed and procured specimens from it."

The sea soon proved so shallow that they could proceed no further. Half a mile from the southern shore they found but six inches water, and beyond, an extensive marsh too yielding for a foot-hold.

Near the eastern shore they encountered a sirocco, which came sweeping from the southeast across the desert of Arabia with a stifling heat. At 8 P. M. their thermometer, which before had ranged from 88° to 97°, stood at 106°. "We could not take our tents with us," says the interesting letter from which we are quoting, "nor did we need them, as we found it more agreeable sleeping in the open air upon the beach."

Having circumnavigated the lake and returning to their place of departure, they found the sad intelligence of Mr. Adams's death awaiting their arrival. Their colors were lowered at half mast, and there out upon the dark waters of this mysterious sea, this little band of true-hearted Americans paid a tribute to the memory of the patriot and statesman, with twenty-one minute guns fired from their frail vessels. The echoes from the cavernous recesses of the lofty and barren mountains which surrounded them, startled the Arabs, and reverberated loudly and strangely upon the ears of the mourners.

The letters of Lieut. Lynch giving an account, *currente calamo*, of his proceedings, are of great value and exceeding interest. We hope soon to have the pleasure of announcing his return to the United States and of welcoming him and his companions back to country, home and friends.

"We have," says he, "elicited several facts of interest to the man of science and the Christian.

"The bottom of the northern half of this sea is almost *an entire plain*. Its meridional lines at a short distance from the shore scarce vary in depth. Near the shore, the bottom is generally an incrustation of salt, but the intermediate one is soft mud with many rectangular crystals—mostly cubes—of pure salt. At one time Stellwagen's lead brought up nothing but crystals.

"The southern half of the sea is very shallow although the northern is so deep; for about one-fourth of its entire length the depth does not exceed three fathoms—(eighteen feet.) Its southern bed presented no crystals, but the shores were lined with incrustations of salt, and when we landed at Uzdom, in the space of an hour, our footprints were coated with crystallizations.

"The opposite shores of the peninsula and the western coast present evident marks of disruption.

"There are unquestionably birds and insects upon the shores, and ducks are sometimes upon the sea, for we have seen them—but cannot detect any living thing within it; although the salt streams flowing into it, contain small fish. My hopes have been strengthened into conviction, and I feel sure that the results of this survey will fully sustain the scriptural account of the cities of the plain."

The greatest depth obtained was two hundred and eighteen fathoms, (1308 feet.) Having completed the survey of the sea, the party proceeded to determine the height of mountains on its shores, and to run a level thence via Jerusalem to the Mediteranean. They found the summit of the precipitous ridge which forms the west bank of the Dead Sea, to be more than a thousand feet above its surface, and very nearly on a level with the Mediterranean.

It is a curious fact, that the distance from the top to the bottom of the Dead Sea, should measure the height of its banks, the elevation of the Mediterranean, and the difference of level between the bottom of the two seas, and that the depth of the Dead Sea should be also an exact multiple of the height of Jerusalem above it.

Another not less singular fact, in the opinion of Lieut. Lynch, "is that the bottom of the Dead Sea forms two submerged plains, an elevated and a depressed one. The first, its southern part, of slimy mud covered by a shallow bay; the last, its northern and largest portion, of mud and incrustations and rectangular crystals of salt—at a great depth with a narrow ravine running through it, corresponding with the bed of the river Jordan at one extremity and the Wady 'el Jeib,' or wady within a wady at the other."

The *slimy* ooze upon that plain at the bottom of the Dead Sea will not fail to remind the sacred historian of the "slime pits" in the vale, where were joined in battle "four kings with five."

June the 9th, the whole party after an absence of a little over two months, had returned to St. Jean d'Acre on the Mediterranean. They brought back their boats in as complete order as they received them on board at New York. The party were in fine health. Save a flesh wound to one man from the accidental discharge of his piece, not an accident or mishap had occurred to any one. The Arabs would point to them and say, "God is with them."*

3. *On a remarkable Slide of a Rock in Fairfield District, S. C.*, (communicated in a letter to Prof. C. U. Shepard by Dr. Wm. D. Kersh.)—The occurrence here described took place on the night of March 12th, 1847. The sliding mass consisted of granitic gneiss, and was of an irregular figure, somewhat flat and oval, with a base approaching quadrilateral. The four edges of the broad side upon which it rested, both prior and subsequent to its translation, measured 7, 17, 7 and 15 feet. It is nine feet in height and forty-five in circumference. Its cubic contents are about four hundred and eighty feet; and

* We have since heard of the death of Lieut. Dale, one of the party, at Jerusalem. We look with much interest for the return of Lieut. Lynch and his final Report.

its weight by calculation between thirty-eight and thirty-nine tons. An overhanging ledge of the same kind of rock is situated up the hill, thirty feet above the spot whence the mass under consideration commenced its slide.

There could be nothing very remarkable in the movement which occurred on the night of the 12th, but for the nearly level surface across which it moved. It is agreed on all hands that the angle of declivity throughout the entire distance which was eighty feet, was only from 13° to 15° 40′. The entire descent for the distance, or the difference between the original and the present level of the mass, is but eighteen feet. The stone did not turn over in its course. The surface over which the mass moved is a gradually inclined plane, unmarked by any natural furrow or depression. The soil is a common loam, five or six inches in depth, while the subsoil is a cohesive red clay. The field had been under cultivation for several years. A crop of wheat was raised upon it the year previous; and of course the ground was not covered by green sward. A few coarse stones and pebbles are observable in the soil. The rock encountered several of these in its progress, some of which were crushed, while others were turned aside. There was much vegetable matter accumulated about the rock (in its original position) in a state of decomposition. The surface of the rock is not blackened as if it had been acted upon by fire, but is covered here and there with the customary growth of lichens. A magnetic needle brought near it is scarcely turned aside from the magnetic meridian.

In its descent, it cut through, or tore asunder numerous roots (of living trees), some of which were two or three inches in diameter. It cut a trench from ten to thirteen feet wide and about three feet in depth, spreading the soil to a distance on either side as it moved along. There is no very considerable accumulation of soil in advance of the stone as it now lies, although portions of the red subsoil appeared scattered down the hill from thirty to eighty feet in front of its present location.

There was rain attended by thunder and lightning on the night of the slide, but unaccompanied by wind; and nothing presented itself in the appearances near the spot to indicate a water-spout or any unusual fall of water.

The only suggestion to account for the removal of the stone which has thus far been made, is that of J. W. Hudson, Esq., the Principal of the Winsboro Academy; it is the following: at the lower side of the original bed of the mass stands a pyramidal rock, four feet in thickness, weighing eight or nine tons. Mr. H. supposes that the heavy end of the sliding rock was supported upon this, which, giving way, produced the motion, which on the ordinary laws of gravitation carried the mass down the inclined plane. From this opinion Dr. Kersh strongly dissents, as he thinks that the shape of the moving mass compared with that of the original bed it occupied, proves such a position to have been impossible.

4. *Contributions to the Mycology of North America.*—Mr. Curtis would make the following additional remark to his article, page 349. Under Helicoma Berkleyi:—add "I suspect that this fine species should form the type of a new genus, for which I propose the name *Systrephium*.

Until a fuller examination, however, it may remain under Helicoma." He observes also, that the number of Bosc's species (p. 350), should have been stated at "eight or ten."

5. *Yield of Lead in Great Britain*, (Mem. Geol. Surv. Great Britain, ii, p. 730).—The following table gives the amount of lead ore and lead afforded by the mines of the United Kingdom, for the years 1845, 1846, 1847 :—

	Lead ore.			Lead.		
	1845.	1846.	1847.	1845.	1846.	1847.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
England, . . .	56,479	54,468	59,614½	38,401	36,718	39,507½
Wales, . . .	16,412	14,978	18,147½	11,014½	10,027½	12,294
Scotland, . . .	1,173	1,161	2,251	901	942	7,380
Ireland, . . .	1,944	1,641	1,159	855½	811	822½
Isle of Man, . .	2,259	2,316	2,575	1,523	1.663	1.699
Total, . .	78,267	74,564	83,747	52,695	50,161½	55,703

It appears from the enquiries that the produce of merchantable lead from the ore throughout the kingdom averages about 68 per cent.; and that 7 to 8 ounces of silver is the average quantity at present procured from the ton of lead.

6. *British Association*, (Athenæum.)—This Association for the Advancement of Science, met at Swansea on Wednesday, the 9th of August. At 8 P. M. an address was delivered by the President of the meeting, the Marquis of Northampton. The summary of the proceedings is as follows: On Wednesday, the General Committee assembled. —On Thursday, business began in all the Sections, the Ethnological sub-section forming the only exception; and in the evening, Dr. Percy delivered a discourse on smelting iron, in the Baptist chapel.—On Friday, all the sections again met except the Ethnological; during the afternoon there were sailing matches and boat races; and after the ordinary, Mr. Vivian threw open his grounds, but the wet weather interfered with the general enjoyment of the Sections. On Saturday there was no meeting of the Sections; and a very large party set off at eight in the morning to visit the iron-works of Ystalyfera, and other points of interest in the Swansea valley. Another party made an excursion to the bone caves and cliffs of Gower; while a third, consisting of Lord Wrottesley, Sir Philip Egerton, Sir H. De la Beche, Prof. Owen, Prof. Forbes, Dr. Carpenter, Mr. Bowerbank, Lieut. Spratt and Mr. Jeffreys, went with Mr. M'Andrew in his yacht, the Osprey, on a dredging excursion in the Bristol Channel. Some of the Botanists, with Mr. Babington at their head, made an excursion around the coast from Oystermouth to Pennard Castle, and obtained many rare plants. The less energetic visited the zinc works of Mr. Vivian, and spent the remainder of the day in Mr. Llewellyn's grounds of Penllergare. Here a boat impelled by the electrical current was at work on one of the lakes. In the evening there was a promenade at the schoolroom, very fully attended.

On Monday, there was business in all the Sections. Dr. Carpenter lectured on microscopic structures in the evening, to a large audience. Tuesday, the Sections met; and the Mayor gave a dinner to the principal strangers. In the evening there was a promenade. On Wednes-

day some of the Sections met; and in the afternoon the concluding general meeting was held for the customary ceremonial proceedings.

The meeting was a good one, though the wet weather interfered somewhat with the comfort and pleasures of the occasion. The amount of scientific business accomplished was less than at many of the preceding meetings.

7. *Lithoceramic.*—MM. CHEUVREUSSE and BOUVERT of Paris, have proposed to replace the timber used for supporting the rails of a railroad, by a mineral compound, to which they have given the name Lithoceramic.

8. *Kumptolite*, (Athenæum.)—The courtyard of the Admiralty, Whitehall, has been covered with a paving of India rubber. It is laid down in pieces about twelve inches square and one thick. The quadrangle at Buckingham palace, formed by the erection of the new wing, will also be covered by this material, which its projectors have named "kumptolite." Its chief recommendation is that it deadens all sound, rendering the passage of a vehicle or horses perfectly noiseless.

9. *Dip of Magnetic Needle.*—According to M. QUETELET, the dip of the magnetic needle at Brussels, on the morning of April 14, 1848, was 68° 0·4 He has kept observations of twenty-two years, and states that in 1827, it was 68° 56·5. The diminution amounts to three minutes a year.

10. *Arctic Expedition in search of Sir John Franklin*, (Athenæum, No. 1089, Sept. 9, 1848.)—A fishing cutter arrived at Stromness, brings the news that an American whaler visiting Lievely, in Disco Island, had learnt that on the 2d of July, Her Majesty's ships Investigator and Enterprize, under Sir John Ross, had reached the harbor, and landed dispatches to the care of the Danish governor, to be forwarded by the first vessel to Europe. The expedition immediately proceeded in search of Sir John Franklin. The crews were all well.

11. *Lithographic Limestone*, (Athen.)—Indian papers notice the discovery in the Deccan, of a bed of lithographic limestone, of great extent and excellent quality.

12. *Ray Society*, (Athen., Aug. 26.)—The Ray Society held its fifth annual meeting at Swansea—the Marquis of Northampton filling the chair. The Report stated that although no great increase of numbers had occurred during the past year, the funds were larger, in consequence of most of the new members subscribing from the commencement. The remaining work for 1847, Prof. E. Forbes's "Monograph of the British Pulmograde Medusæ,"—with three new works, Part iv, of Messrs. Alder & Hancock's "Nudibranchiate Mollusca," the "Correspondence of John Ray," and vol. i, of the Bib. Zoologiæ et Geologiæ of Prof. Agassiz, for 1848, were stated to be ready for distribution. Though all the works for 1848 were ready, not a third of the subscriptions for that year had been paid. The meeting was well attended, and several new members were added.*

13. *Museum of Economic Geology, England.*—The building for this museum is nearly completed on an excellent site in Piccadilly; £30,000

* Subscribers in this country will hereafter receive their copies, through Mr. G. P. Putnam, publisher and bookseller, in New York and London, who has been appointed agent for the Society.

of the public money were voted for its construction some years ago. It is suggested that the Geological Society should be furnished with rooms in the building.

14. *Interesting Collections for sale.*—The attention of *colleges, academies, public schools, and private collectors* of objects of natural history, literature, &c., is invited to the following notice:—

A private gentleman who in the course of a long life, as opportunities have offered in Europe and America, and at considerable expense, has indulged his taste in collecting various objects of art, science and literature, and being now too infirm, as well as advanced in life, to prosecute these pursuits, and indeed feeling unable to take the necessary care, has concluded to relieve himself, by disposing of such a portion of his collections as he can spare, retaining only what may require less trouble, while contributing to his enjoyment during the rest of his life. He therefore takes this mode of offering it to the public and private institutions of his country, as an opportunity of obtaining rare and valuable objects, not often to be met with and not to be neglected. The first is

A collection of minerals made in this country as well as in Europe, containing most of the species and many of the varieties mentioned by Professor Cleaveland in his treatise, and many, perhaps more crystalline forms than are to be found in other American cabinets, with few exceptions; among them there is a fine crystal of gold, which attracted the notice of Professors Vanuxem and Shepard, a double terminated euclase, double terminated topazes, and two imbedded in quartz crystals, and a perfect crystal of the gieseckite brought from Greenland by Professor Giesecke of Copenhagen, probably the best in the country. Most of the specimens are of moderate cabinet size, calculated to be contained in a case convenient to occupy nearly one side of a room, and almost all are *ticketed;* many with the original labels of the Abbé Haüy, Brongniart, Brochant, Klaproth, Gillet Laumont. Lucas, and Patrin, as well as of other distinguished mineralogists The duplicates which are not arranged, containing larger specimens, and one especially of the Ackworth Beryl, being a fragment of a crystal about fifteen inches long and near a foot in diameter, the sides of the prism are six inches across. There are also geological and fossil specimens.

Together with the minerals will be sold a set of crystalline forms in wood (with the angles all marked), and those illustrating crystallography. These models were made under the direction of the celebrated Abbé Haüy for the Emperor of Austria, but learning they were wanted for America, he yielded them to the present owner and ordered a new set for the Emperor.

Further information can be given by Professor Silliman, Professor B. Silliman, Jr., and C. U. Shepard, Professor in the Medical College of South Carolina, Charleston, and at Amherst College, who are acquainted with the collection and know its value. There is also

A cabinet of ancient and modern coins and medals, consisting of Greek, Roman, and Colonial coins in gold, silver, brass, bronze, copper, and lead, with Asiatic and African colonial coins, and several finely executed ones of the Brettii, an ancient people who occupied the lower part

of Italy. The modern coins are of gold, silver, and bronze or brass, and some of them scarce and valuable. Among the gold coins of England there are three fine guinea pieces, of Charles II, Queen Anne and George I. Likewise

A collection of European and American autographs in forty quarto cases bound as books. They have been chiefly collected by purchase at considerable cost. The American includes a complete collection of the signers of the Declaration of Independance.

It is unnecessary to go into further details.—Those desirous of availing themselves of so good an opportunity of purchasing, either for private use or for endowing public institutions, will probably desire to examine for themselves, when the fullest information will be afforded.

OBITUARY.

15. *Berzelius*, (Athenæum, Aug. 26, 1848.)—On the 7th August, aged 69, died the eminent Swedish chemist, Berzelius. In a century which has produced a greater number of distinguished chemists than perhaps of any other class of men of science, Berzelius stood out as a star of the first magnitude. To him more than to any other man, belongs the honor of applying the great principles which had been established by Dalton, Davy, Wollaston, Gay-Lussac, and himself, in inorganic chemistry, to unfolding the laws which regulate the combinations forming the structures of the animal and vegetable kingdoms.

Berzelius was born in the village of Väfversunda, in the canonry of Linkogring, in Ostgothland, on the 29th of August, 1779,—not at Linkagring on the 20th of August, as is often erroneously stated in the many notices of him. His father kept the parish school in the village where young Berzelius was born, and there he appears to have received his early education. At the age of seventeen he commenced his studies at the University of Upsala, hoping to qualify himself for the medical profession.

In the year 1798, Berzelius passed his philosophical examination as preparatory to the final one for M.D. At this time he left the University; and in 1799 we find him assistant to a Dr. Hedin, a superintendent physician of the mineral waters of Medevi. The composition of these waters attracted the attention of Berzelius, and his first published essay was a dissertation in conjunction with Ekeberg on the mineral waters of Medevi. He underwent the examination for a license to practice medicine in 1801, and graduated at Upsal on the 24th May, 1804. On leaving Upsal, Berzelius repaired to Stockholm; where he became assistant to Andrew Spaurnau, who sailed with Cook in one of his voyages round the world, and was then professor there of medicine, botany, and chemical pharmacy. Spaurnau died in 1806,—and Berzelius by his inaugural dissertation on galvanism, and other papers, had already obtained for himself a sufficient degree of confidence to be appointed his successor. Although this chair embraced a very wide range of subjects, as was frequently the case with Swedish chairs at that time, Berzelius devoted himself more especially to chemistry. At first he was not more successful in teaching chemistry than his predecessors; but having received a hint from Dr. Marcet of London that chemical

lectures should be illustrated by experiments, he adopted this plan, and likewise abandoned the old practice of reading lectures. He used to express himself very strongly on the inutility of merely reading lectures. Although he first adopted Dr. Marcet's experiments in his class-room, he soon so far improved upon these, that his own became a model for the chemical class-rooms of Europe.

During the early period of his residence at Stockholm, he practised the profession of medicine, and in 1807 was mainly instrumental in forming the Medical Society of that capital. In 1810 he was made President of the Royal Academy of Sciences at Stockholm; and in the same year received the appointment of Assessor of the Medical College; and was made a member of the Royal Sanitary Board. At this time, though scarcely more than thirty years of age, he had obtained great reputation as a chemist. He had published a work on animal chemistry, containing many original investigations on the fluids of the animal body, and which was subsequently translated—as, indeed, have been most of his works—into almost every language of Europe. In conjunction with Hisinger, he commenced, in 1806, the publication of a periodical work entitled, "Afhandlingar i Fysik, Kemi, och Mineralogi,"—which contained a series of papers by himself, constituting some of the most valuable contributions that had yet been made to analytical chemistry. His labors were regarded of so much importance by the Royal Academy of Stockholm, that that body decreed him, in 1811, 200 dollars yearly for his chemical researches. In 1812, Berzelius visited England, where he was most cordially received. In that year he communicated, through Dr. Marcet, a valuable paper to the Medico-Chirurgical Society of London, "On the Composition of the Animal Fluids." In 1818 he visited France and Germany—countries in which he was better known than in Great Britain, as most of his papers and works were published in the languages of those countries, as well as in that of Sweden. In the same year he was appointed Secretary to the Academy of Sciences—a post which he held till his death. In 1831 he was allowed to retire from the active duties of his professorship at the Caroline Institute, but he still held the title of honorary professor. Up to this time he had resided in apartments provided for him at the building occupied by the Academy of Sciences,—where, on the same floor, he had his study and laboratory, so that he could with little difficulty pass from his desk to his crucible, and husband his time to the greatest possible extent. He now, however, moved to a house of his own,—and in 1835, married a daughter of the town-councillor (Staatsrathe) Poppius. In 1837 he received the Great Gold Medal of the Royal Academy of Stockholm,—and in 1840 the Diet of Sweden voted him a pension of 2,000 dollars per annum. The scientific societies of Europe and America contended for the honor of enrolling his name among their members,—and with eighty-eight of these bodies it was connected. Nor was his sovereign, Charles John, behindhand in recognizing the most distinguished of his adopted countrymen. In 1815 Berzelius was made a Knight, and in 1821 a Knight Commander, of the Order of Vasa. In 1829 he received the Grand Cross, and in 1835 was made a Baron. The intelligence of this honor was conveyed to Berzelius by the hand of the King; who wrote himself a letter intima-

ting his deep sense of the merits of the philosopher, and expressing a hope that in this nomination the world would recognize an homage paid to the man who had consecrated his life to those useful researches which had been already recognized by Europe, and which it was the glory of Sweden to be able to appropriate as the patrimony of one of her children. This letter was sent to Berzelius on his wedding-day. How few men of science have married with a patent of nobility on the breakfast table! Sweden had, however, yet one more ovation for her beloved son. In 1843 he had been a quarter of a century Secretary to the Academy, and on this occasion a festival was given in his honor. The Crown-Prince was in the chair,—and a portrait of the chemist painted by Lieut. Col. Lodemark was presented to the Academy.

In addition to the works already mentioned, he published a "Manual of Chemistry," which went through several editions, that of 1841 consisting of ten volumes,—and, we believe, another larger edition has since been published. In 1822 he commenced the publication of an Annual Report on the Progress of the Physical Sciences, which has been published every year to the present time.

The name of Berzelius has been too intimately connected with the history of chemistry for the last forty years, for us in this slight sketch to give an adequate idea of the influence which his discoveries and generalizations have exerted upon the science. To him it is indebted for the discovery of several new elementary bodies,—more especially selenium, thorium and cerium. He first demonstrated the acid nature of silica, and was thus enabled to throw light on the composition of a series of interesting mineral compounds of silica with the metallic oxyds. This subsequently led to a whole re-arrangement of mineral bodies, and contributed greatly to the advance of mineralogy. His discovery of selenium led him to investigate its various compounds, and compare them with the sulphurets. These investigations again resulted in his generalizations on the nature of the sulphur salts, and a new classification of the various salts. Subsequently, he investigated the compounds of fluorine, and arrived at some of the most important and valuable results that have yet been obtained by the analytical chemist.

Whilst Berzelius was writing the first edition of his "Manual of Chemistry," Dalton had promulgated his idea of the atomic constitution of matter, and Davy had made his great discovery of the metallic bases of the alkalies. These directed his attention to the laws of combination. He was led to institute researches with the most scrupulous care into the combining proportions of the various elements, giving to each its correct number, and was enabled to obtain results perfectly harmonious with theoretical calculations made on Dalton's laws. He was enabled to extend Dalton's law that one atom of one body unites with one, two, or three, &c., atoms of another body, and showed that two atoms would unite with three and five. He also pointed out the great fact, that two compounds which contain the same electro-negative body always combine in such proportions, that the electro-negative element of one is a multiple by a whole number of the same element of the other. He not only gave to the elementary bodies their combining numbers, but introduced the system of symbols, by which chemical labor has been so greatly facilitated. Till the time of Berzelius, organic

chemistry was a waste, with here and there an attempt to explain the phenomena of living beings upon chemical principles,—and which from the entire want of experimental foundation, was even worse than useless. The compounds found in plants and animals were not supposed to come within the category to which the laws of combination applied. Berzelius was the first to show that these laws could be applied to animal and vegetable products; and in so doing, he opened the way for the discoveries of Mulder, Liebig, Dumas, Boussingault, and others.

As a skilful manipulator, Berzelius has had few equals in the history of chemistry. To this we are indebted for the immense variety, number and success of his analyses. Many of the analytical processes in use at the present time, have had their origin with him.

The personal appearance of Berzelius was that of a strong, healthy man, with nothing in his habits or manners to impress a stranger with a sense of his powers. A chemist who visited him says, "He has nothing of pretense, reserve, or singularity about him; so that his plainness drew from a fellow-traveller of mine, whom he allowed me to introduce to him, the observation, 'I would never have thought him the great man he is said to be.'" His attention to strangers was very great,—especially to those who took an interest in chemistry. With these he would frequently spend hours in his laboratory, explaining his methods of working,—and on their departure, he left the impression that he was the honored party. He was an early riser, and gave the first part of the day to his most important work, whatever that might be. He seldom either wrote or experimented in the evening, leaving that part of the day for reading and social relaxation. He had no particular times for writing or experimenting; when he had a work to finish, he would write sometimes for months without performing an experiment,—but if anything of importance occurred to him during his writing, requiring further investigation, he would at once give up the pen, and work perhaps for weeks in his laboratory. Few men were more beloved in the city of Stockholm than Berzelius.

Were the merits of this great chemist less, we might not be able to afford to hint at any defects. But regarding him at a distance, he appears to us to have carried his caution beyond the requirements of scientific research. His feelings were conservative, and though constantly going forward to the new, he still clung with tenacity to the old. He was almost the last chemist of eminence that admitted Davy's theory of the elementary nature of chlorine. Even after envy and prejudice had given up their opposition, the caution of Berzelius withheld assent. In the recent advances of organic chemistry, also, and more especially in its applications to the physiology of plants and animals, Berzelius has looked on with the eye of a critic, and withheld to the last his adhesion to some of the advanced positions of this department of the science.

A letter from Retzius, (L'Institut, No. 764,) speaking of Berzelius, states that on examination, it was found that there was a softening of the posterior half of the spinal marrow corresponding to the tenth dorsal vertebra.

VI. Bibliography.

1. *Rare and Remarkable Animals of Scotland, represented from living Subjects, with practical observations on their nature;* by Sir John Graham Dalyell, Bart. Volume first, containing fifty-three colored plates. London: John Van Voorst, Paternoster Row, 1847. 4to, pp. 270, (Ann. Mag. Nat. Hist., ii Ser., i, 311, 1848.)—The most interesting chapter in this interesting volume is that which narrates the history of the *Hydra tuba*. This marine animal is called a Hydra by our author because it has the form and the characters of the freshwater polyps, and possesses also their qualities—their greed of living prey (p. 87), their proliferous evolution of young, their endurance of privations, their power to recover from apparently immedicable wounds, and their strange germinations and monstrosities under the influence and direction of the experimentalist (p. 93). This hydra is found attached to submarine bodies; the body is fleshy, inversely conical, encircled about the oral disc with a series of long slender thread-like tentacles,—and thus it lives apparently for an indeterminate period, exercising all the functions of a perfect and adult animal even to the repeated production of young in all respects alike the parent. So it lives until, from some unknown causes, a change comes over it, and it begins to unveil itself, and to exhibit one of the most wonderful revelations in animal transmutations. A pendulous column or roll is observed as if implanted on the disc of the hydra; at first it is faintly indented by circles and is terminated by a circular row of tentacles; the indenting circles become more deeply waved, the tentacles shorter until they are obliterated; and then each roll of the column is successively separated and liberated from the others until the whole embryonic column is dissolved, the individual rolls floating at freedom in the bosom of the waters, obviously the young of one of those large Medusæ which swarm our seas in the months of the latter summer and autumn! —Now this short sketch of the metamorphosis is not of any new discovery, for Sars had made us in some degree acquainted with it, but the account of it given by Sir John Dalyell excels all others in fullness and completeness, and in its freedom from conjectural explications. The metamorphosis itself is wonderfully curious, but what strikes us as the most unaccountable fact in the process is the uncertainty of the periods at which the change takes place. The *Hydra tuba* may remain for years a hydra propagating its kind, and we know of no data to fix the period when it shall begin the process of change into its mature and final state; and, to add wonder to wonder, having cast off several of these medusean embryos, a basis remains out of which another *Hydra tuba* shall arise, to go through the same hydra life and the same medusean metamorphoses as its predecessor. We suppose that these facts—for facts they are—will not support the opinions of Steenstrup on alternating generations, nor can even be reconciled with them.

The way in which Sir John discovered that the *Hydra tuba* was the embryo of a Medusa was this: he took a large Medusa, of undetermined species but beautifully figured on plate 15, and placing it in a

vase of sea-water the spawn—"a brownish matter like dust"—was shed from its ovarian fringes and settled at the bottom. This spawn consisted of "an host of animated creatures in quick and varied motion," partaking much of the nature of the *planules* of the Sertularians. The changes they rapidly underwent were noted and delineated; and in eleven or twelve days after "the planule had been discharged from the unwieldy Medusa, it was converted to a stationary hydra," (p. 105.) "This new animal was provided with a complement of eight arms, yet so immature as to be of unequal dimensions. Different groups, under metamorphosis, showed the utmost irregularity in respect to evolution, in their shape and proportions: nor was it until thirteen days later, or three weeks after their birth, that any appeared with eight regular tentacles. Thus was a most perplexing problem solved—the *Hydra tuba* proved to have sprung of a Medusa." (p. 105.)

The progress of discovery went on. Sir John had "remarked colonies of minute transparent animals swimming in vessels of sea-water, during the months of February, March and April. Their general aspect very much resembled a flock of birds in distant flight, as represented by landscape painters. After being transferred to vessels free of other subjects, they continued several days in activity and then disappeared. I could not account either for their origin or their transience. They occurred only at rare intervals, and always identically under the same form." (p. 111.) These very minute beings, for the expansion of an individual is only between one and two lines, were evidently allied to the Medusæ "both in configuration and in habits," but they differed from the Medusæ in the early date of their appearance. To distinguish them Sir John called the species *Medusa bifida*, and we have it minutely described and variously figured. Sir John was first led to remark that it was chiefly observed in vessels containing the *Hydra tuba* (p. 114); and subsequently, and as it were by accident, he discovered that the hydra was in fact their source; and moreover that the hydra was identical with the *Strobila* of Sars! The discovery is told in a most interesting manner, and with a truthfulness which there is no gainsaying.

We shall quote only a few of the many passages we have marked, previously observing that the *Hydra tuba* in its strobila form is something like a fir-cone or a cylinder cut into several whorls, each whorl, when detached, becoming what is named the *Medusa bifida*. The strobila throws off these whorls in succession to the number of from ten to twenty, when the basis, as already stated, resumes the form and habits of the hydra.

"First, a smooth fleshy bulb sustained a cylinder of about half its own diameter, indented by plain circles, which were soon converted to waving curvatures. A row of twenty or twenty-four tentacula crowned the summit of the cylinder, which row disappeared or was obliterated as the waving in its vicinity deepened, and the diameter of the cylinder there expanded, that is towards the summit. Concomitant on obliteration of the terminal row, a new circle of tentacula, at first few, but gradually augmenting, was emerging from around the bulb, while the struggles of Medusæ, into which the waving strata were evolving, accomplished their liberation to swim unconstrained in the surrounding element." (p. 121.)

"Certain facts admit of no dispute; such as the existence of a vigorous hydra attached to a solid substance, with long flowing silky tentacula; an alteration in the figure of the body, or the formation of an embryonic roll of Medusæ on the disc; the gradual maturity of each Medusa and its liberation from the roll; the disappearance of the original tentacula of the hydra; the emerging of a new circle of tentacula from a smooth fleshy bulb, sustaining the embryonic roll, as the former are obliterated, and as the Medusæ approach maturity; the evolution of this fleshy bulb as a perfect hydra, along with their departure, which becomes the parent of progeny by gemmation, and its permanence as an independent animal." (p. 122–3.)

"All the Medusæ in the embryonic roll are separate and distinct animals. Each is in close application to that which is next below, if itself be uppermost, or lies between two if intermediate. The proboscis is outermost if the individual be uppermost in the roll; thus all lie in the same direction, the proboscis outermost, as the Medusa escapes, from the next left behind. When the last remains in adhesion to the fleshy bulb, its proboscis projects outwards also. Thus the under surface of the embryo is always outwards, while a portion of the roll." (p. 124.)

"Although by repeated long, and painful observation, I have endeavored to learn the history of the *Hydra tuba* and the *Medusæ* originating from it, my purpose has been but partially attained. I have selected many individuals, and I have chosen colonies of both, to discover whatever changes they should undergo. The hydra grew, it fed, it bred, its existence was long. The Medusa lived, it neither fed nor bred, its existence was infinitely shorter; nor did it undergo the smallest change from the first moment of liberation for fifty-five days. Its life could not be protracted, on any occasion, beyond sixty days. Between the form and habits of these two animals there is not the smallest correspondence." (p. 128.)

2. *Recherches sur les Animaux Fossiles;* par L. de Koninck. Liége, 1847. *Première Partie, Monographie des genres Productus et Chonetes.* 4to, illustrated by 20 plates. (Ann. and Mag. Nat. Hist., ii Ser., i, 457, 1848.)—This is the first of a series of works entitled, 'Researches on Fossil Animals;' it contains monographs of the genera *Productus* and *Chonetes*. The series is intended to supply the geologist and naturalist with complete monographs of different genera, so as to embody in one work all the species of a genus which are now more or less distributed through many periodicals, memoirs and transactions of societies. The first part contains a list of 107 works and memoirs to which the author has referred in the subsequent pages. To this succeeds an historical introduction and observations on the generic characters, with a classification of the species. A detailed description of each species is given, to which is appended a very complete synonymy. From the geological and geographical distribution which follows we extract a few notes. The number of species of *Productus* described amounts to 62, of which 4 are Devonian, 47 Carboniferous, 10 Permian, and 1 Triassic. Of the 47 Carboniferous species, 35 only are found in the lower divisions.

Not any species belongs exclusively to the middle division, although 7 are common to the lower and middle portions, viz., *P. margaritaceus*, *undiferus*, *Flemingii*, *pustulosus*, *Keyserlingianus*, *aculeatus*, *mesolobus*. The *P. carbonarius* is found only in the upper division. The *P. cora*, *semireticulatus*, *scabriculus* and *punctatus* appear to have lived from the commencement to the close of the carboniferous period.

It is interesting to observe that all the Devonian species have common general characters, and may be arranged in the same group (Caperati): a similar remark also applies to the Permian species, which, with the exception of three, are nearly all comprised in the group (Horridi), so that the latter group is almost composed of Permian species, the *P. Orbignianus*, *P. Verneuilianus*, being the only carboniferous forms; and it is not a little singular, in consulting the table of classification (page 29), to find that the Permian species have a much greater affinity with the Devonian than with the carboniferous, notwithstanding the considerable period which must have elapsed between their development.

Under the geological distribution of the genus *Chonetes*, we find there are 23 species known at present, which number may probably be increased when the fossiliferous deposits of America, New Holland and Asia are more explored. Nevertheless the geological results to which the known species lead us are deserving of notice. From the observations of M. de Koninck it appears (contrary to the opinion generally admitted), that with the exception of one, not any of the 23 species pass from one system to another, or even from the lower to the upper beds of the same system.

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Ofversigt af Kongl. Vet.-Akad. Förhandlingar, 1847.—Includes the following, on Natural History topics:—p. 5. New Algæ from Mexico; *Agardh.*—p. 54. Specific gravity of Zircon; *Svanberg.*—p. 70. Neolite, a new mineral; *Scheerer.*—p. 85. Aphthonite, a new antimonial sulphuret of copper and silver; *Svanberg.*—p. 162. A new goniometer; *Wallmark.*—On the teeth and uncini of mollusca, with figures and descriptions of these appendages in over 80 species of different genera; *Loven.*

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